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Electrical World

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Research and Analysis: The Opportunity of the Year 1917

SEARCHING analysis should accompany and result from the present great activity in the electrical industry. Production has been the rallying cry for 1916. Need for greater output has taxed capacities of engineering resources, of manufacturers, of central stations and other generating plants and of distributers of electrical products. New standards in gross output have meant the overhauling of industrial methods, and out of this comes a lesson which 1916 passes along to 1917.

Research is no longer merely a laboratory viewpoint, but a necessary approach to the problems of the industry. New economic conditions, forced by the great war, have emphasized the need of a broad interpretation and application of the principles of research in all industry.

High prices, scarcity of materials, shortages in labor, unprecedented increases in volume of business, have demanded immediate readjustment of accepted standards. These conditions have turned engineering and manufacturing and commercial branches to closer analyses in an attempt to eliminate wastefulness, whether in design, in manufacture, in distribution or in sales plan, and to provide new ideals for the future.

In scientific and engineering branches the need of unrestricted research for new laws and new principles has been given fresh impetus by the lack and scarcity of materials, growing out of war and acute industrial conditions, and due to our past failure to consider research work in the correct perspective. Similarly, in the critical analyses of manufacturing costs, the more general insistence on new standards in the cost of doing business, the discussion of service costs and rates, serious consideration is being given to basic factors which may be broadly interpreted as a part of a research movement.

The spirit of research has never been far from the electrical industry. In the early days scientific and engineering research gave birth to the art. With the ramifying of the industry has come a growth of the movement. In 1916 it is found expressed not only in the laboratory and the design room, not only by the laboratorian and the engineer, but by the manufacturer, by the distributer of electrical products, by the central station and by the user.

A new impetus is being given to pure research for the discovery of new laws and principles. The background and purpose of this movement are discussed in Dr. Whitney's article in this issue. Research has made its appearance, though not by that title, in the field of practice outside the laboratory. The leading articles in this issue voice the new attitude in engineering and industrial affairs. Scientific progress in industry is no less an expression of the spirit of research than the creation of government and private laboratories.

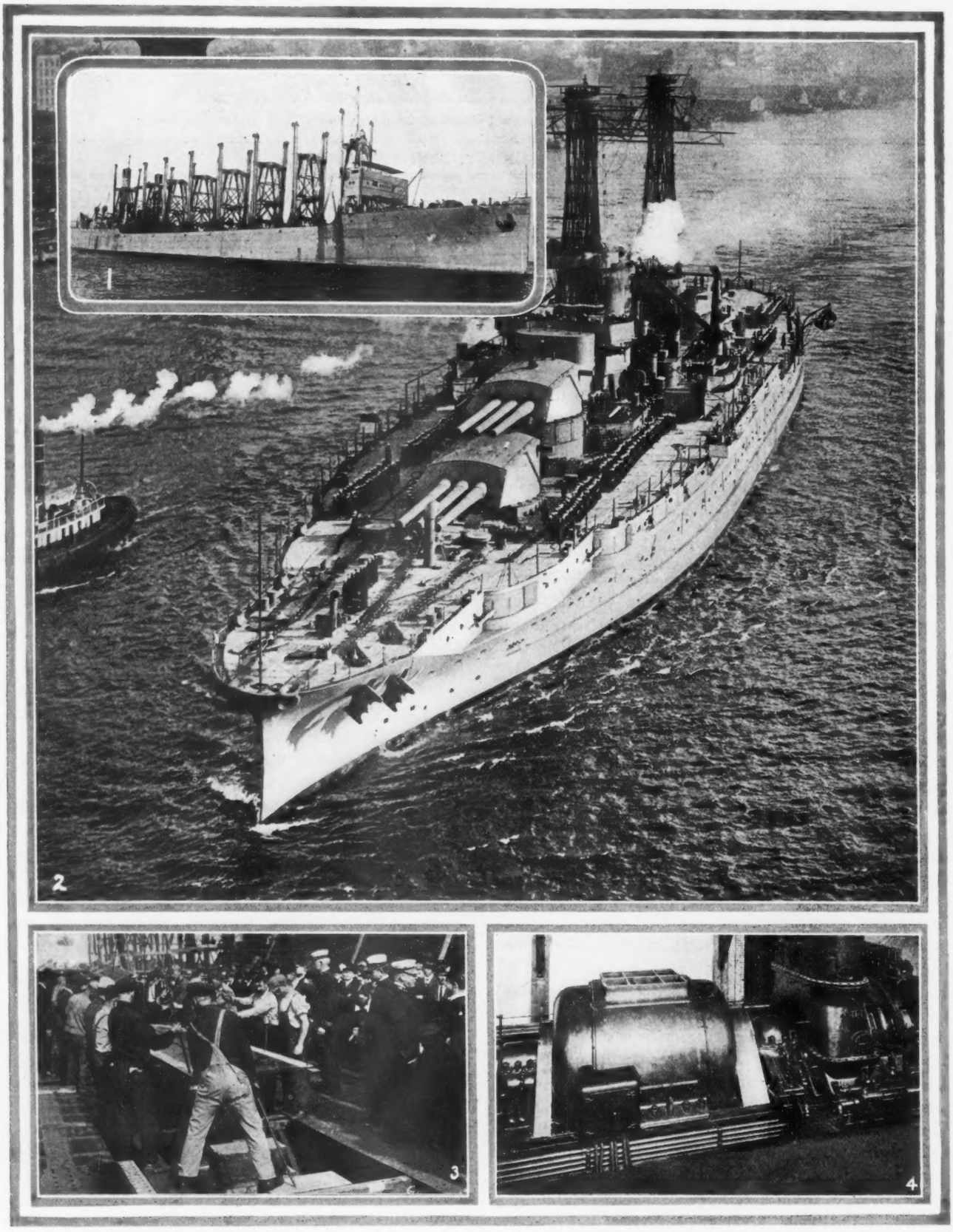
Our nation has awakened and is discussing its economic relations within itself and with other nations. We are thinking of problems outside our own boundaries. Many men enter the year 1917 with a new conception of the relation of the branches of the industry to each other and of the relation of the industry to other arts and industries.

We need this year to have big men thinking on the big problems. More research in known fields of usefulness, more design with new standards of cost, more planning and better directed sales effort, more public education on the relation between financing, cost and rates of public utilities, a keener realization of the relation of the electrical engineer to all these activities —these are great demands which the new year brings to the electrical industry.

THERE will be no failure to respond to the demands of the times. The industry is conscious of its shortcomings in the past. It has men and it has organization. With its highly developed organizations of country-wide associations, the industry has an excellent foundation upon which to base its new outlook. The systematic and efficient co-ordination of all of these factors presents a task which both the scientist and the practical engineer will welcome as a real opportunity.

THIS issue, conforming to the custom of the ELECTRICAL WORLD, *presents signed articles from engineers and business men in the industry upon important developments and tendencies of the times. It is a period when clear judgment and prophetic vision are sorely needed; and the contributions in this number take the conservative "look ahead" which will help our readers to solve the problems of the New Year.*

On account of lack of space in this number, several articles which it had been intended to publish were unavoidably withheld and will be published in subsequent issues during January.



Within a month or two there will be launched at the Brooklyn Navy Yard the *New Mexico* (at first called the *California*), the first battleship of any nation to be electrically propelled. In size and fighting equipment the *New Mexico* is the sister ship of the newly commissoned *Arizona*, pictured above (2). In the insert at the top of page (1) is shown the electrically propelled collier *Jupiter*, tests on which led to the adoption of electric propulsion in the Navy. In the lower right-hand corner (4) appears one of the *Jupiter's* prime-mover sets, and at the left (3) is pictured the ceremony of laying the keel of the electrically propelled *New Mexico* in the presence of Secretary Daniels and other officials, early in 1916.

Electric Propelling Machinery Has Been Ordered for Our Seven Latest Battleships, and Is Specified for the Four Great New Battle-Cruisers.

W. L. R. EMMET

". . . When prejudices are overcome electricity will develop an extensive use in large high-power warships. In . . . scouts and destroyers . . . it is relatively much less desirable, but even in such cases . . . it might . . . develop a legitimate application. In merchant ships also it may afford great advantages."

Advantages and Future of Electric Ship Propulsion

BY W. L. R. EMMET
Consulting Engineer, General Electric Company

THE writer has been asked to write an article on the future of electric ship propulsion, and while prophecy is generally an undesirable task for an engineer, the present conditions seem to be such that a statement of opinion is desirable.

The writer has for many years actively advocated electric drive for the larger vessels of the navy, and as a result of a long campaign of designing, experimentation and educational activity this method has been adopted on a large scale by our Navy Department. Electric propelling machinery has been ordered for the last seven battleships which have been authorized, and is specified for the four new battle cruisers which form part of the present naval program. These battleships are very large and important vessels, requiring 33,000 hp. each, and the battle cruisers present the most stupendous propulsion problem ever brought forth, since they require no less than 180,000 hp. each. Only two or three of our cities use as much electricity as will be generated on one of these ships at 35-knot speed.

Electric propulsion has from the first had many opponents, and it is still being very actively opposed by nearly all the shipbuilders of the country, by Sir Charles Parsons, Charles G. Curtis, and others who have had important influence in marine engineering. Most of this opposition is undoubtedly sincere, but is not altogether disinterested, since shipbuilders want to use machinery which they know how to build, and since turbine inventors have in the past received large royalties from turbine-driven ships which are cut off by the advent of electric drive. Although the power still comes from turbines, the electric drive is, by license agreements, free from royalty charges. The possibilities of large electrical apparatus do not appeal strongly to those who are not thoroughly familiar with its uses. Electric propelling machinery will be generally heavier and more expensive than the best developments of geared turbine machinery, and variations of opinion have rested upon the relative importance given to advantages and disadvantages.

The General Electric Company has, under the writer's direction, also carried on extensive developments and operations in ship propulsion by turbines connected to ships' propellers by gearing. Machinery of this class for seventy-nine large vessels has been contracted for by them, and many of these ships are in service and showing unqualified success. Our view, therefore, is not entirely one sided, and although it may be considered that we are particularly interested in the development of the uses of electrical machinery, we believe that we have judged fairly and that our efforts will lead to important and lasting success.

ADVANTAGES OF THE ELECTRIC DRIVE

In explaining the advantages of electric drive, comparisons will be made only with the geared turbine drive. All other methods for propelling large vessels may be considered obsolete, although many ships are still being built with engines or with direct-connected turbines.

A wise rule in engineering is to advocate new things only for the purpose in which they afford the greatest advantages, and this rule has been closely followed in the promotion of electric propulsion, which was originally advocated mainly for large warships. This first move was made before the use of mechanical gearing, for such a purpose had been suggested, but its advantages for this particular use are so striking that it is still believed that the wonderful development of gearing possibilities have not changed the original case.

The subject of electric drive is too large for full discussion in such an article as this. Its possibilities and advantages can be best suggested by taking as an example the case of the new battle cruisers in which its use has been and still is the subject of much discussion and criticism. This may be considered as the extreme case where advantages are most important and in which the disadvantages of increased weight is most serious.

Four of these vessels are authorized in the navy bill of 1916. They are designed to make 35 knots each, requiring 180,000 hp. delivered to four shafts turning at full speed about 250 r.p.m. These are the fastest and most highly powered vessels ever built. The electrical installation proposed in each of them far exceeds in extent any single installation ever made for any purpose.

APPARATUS PROPOSED

It is proposed to install in these ships four high-speed turbine-driven generating units of the best type, similar in most respects to those used in power stations on shore. Upon each of the four propeller shafts will be mounted two independent induction motors. Cable connections and switching arrangements will be provided by which any combination of motors and generators can be immediately provided for and by which all the changes of connections for operation, reversal, etc., can be instantly made under all running conditions. The details of design and method of operation need not be described in this discussion. They are quite simple; in fact, much simpler than in most electrical installations. The electric supply is produced for the one purpose of propulsion, and is varied or discontinued according to need. Connections are changed only on dead circuit, even in the ordinary operations of stopping, starting and reversing, and automatic means are provided by which any diversion of current from any cause produces an unbalancing which instantly breaks the field circuit and de-energizes the system.

The aggregate weight of this equipment with cables, switches, instruments and controlling apparatus is 1865 tons.

EQUIPMENT IF GEAR DRIVEN

If such a vessel were gear driven, a plurality of ahead turbines would be connected through helical gearing to each propeller shaft, one or more backing turbines would also be connected through the same gearing, and if good cruising economy was sought, it would be necessary to provide also cruising turbines connected through separate systems of gearing and arranged with couplings so that they could be detached during high-speed operation.

A just comparison of this method with the electric equipment proposed would require a complete design and analytical study of the geared equipment and its performances. The writer has not made such a study in the case of these vessels, therefore no exact figures can be given. The space and number of turbine elements connected to each shaft will determine the space required for turbines, and this spacing will govern the length and weight of the shafts, piping, valves and supporting structures.

In some of the installations which have been proposed abroad for vessels of much less power than these, the multiplication of parts has been very great and the size and extent of turbines and supporting structures such that the adoption of similar methods in these ships would certainly give weights nearly as great if not greater than those proposed for the electric drive. Some of our ship builders in bidding to the government on these vessels have stated that by using geared equipment they could save about 1000 tons in weight and about $1,000,000 in cost, but whether these statements will bear analysis or not cannot be said without study of their detailed designs, if any have been made.

DETACHMENT AND INTERCHANGEABILITY

Without further description or discussion of either type of apparatus, we are in a position to make a comparison which constitutes one of the most important advantages of electric drive. In the geared equipment, each shaft has a system of turbines, gears, bearings, thrust balancing devices and lubricating systems all mechanically locked together. With high-speed machinery any kind of trouble with any of these parts will almost certainly necessitate the immediate stoppage of the whole system. To keep a high-speed turbine running out of balance or with bearing trouble is impossible, and the gearing part would present almost equal difficulty. In the event of mechanical trouble of such character a ship would have to be stopped until the wreck could be cleared. The work necessary to uncouple and disconnect any part of such very heavy apparatus would be a serious matter involving much time, including that required to stop the ship. After the disconnection was made the idle propeller would act as a very serious drag on a fast vessel.

In the electrically driven ship there is no mechanical connection of the shaft to anything but the rotors of motors. These are self-contained, iron-clad structures and cannot by any possibility be subject to mechanical interference. The shafts are subject to the same possibilities of bearing or thrust trouble as shafts in other ships, but the presence of the motors does not increase this danger, and the speed being low it is remote in any case. With this equipment any motor, generator or turbine, if in any kind of trouble, can be instantly disconnected without stopping the ship and with only a small loss from the highest speed capacity.

Such interchangeability as this power of disconnection gives constitutes one of the most important advantages of electric drive in such a ship. With one motor out of eight in trouble, only one-eighth of the maximum capacity is lost and the ship's maximum speed is impaired by only about 1 knot. If a generator or turbine is in trouble the maximum speed is reduced only about 2 knots. With two generating units and four motors out the ship can make 26 knots, and with three generators and four motors out she can made 19 knots. If parts give trouble they are simply cut out and repaired at leisure or as opportunity offers. The value of this interchangeability in a warship can hardly be overestimated, it largely overcomes the military danger incident to accidents to the driving power, a danger which has always been of primary importance.

BACKING POWER

In turbine-driven ships, not electric, it is necessary to provide backing turbines which must run idle in the reverse direction when the ship is going ahead. These backing turbines involve complications which are very objectionable, and if these are reduced to a desirable minimum the backing power will be greatly inferior to that easily provided with electric drive. Experiment has shown that a turbine forced in an opposite direction involves about seven times as much friction loss as when driven in its normal direction. This loss is very appreciable in the backing turbines of ships and causes heating which must be dissipated by circulating steam, which causes further loss and waste. There are also serious difficulties and dangers in high-speed apparatus incident to the abrupt and wide changes of temperature where steam is suddenly admitted to a cold reversing turbine. Steam which expands without doing work has a high temperature, and if work is done upon it by a reversed turbine the heat is considerably increased. With superheat these temperatures may be extreme, and they affect the main turbine as well as the other, since it also must be used for reversal of direction and since the two often occupy the same casing. The mechanical effect of such abrupt change of steam temperature upon fragile structures presenting very extended surfaces is a matter which has been little considered, but which has caused much serious trouble. With electric drive the turbine never need be stopped when the ship is under way, and its operation is easier than in a power station because the load is steadier. with modern high-speed turbines superheat affords large gains in fuel economy, and the ability to safely use high degrees of superheat may constitute one of the important reasons for adopting electric drive.

EFFICIENCY OF TRANSMISSION

Various statements and estimates have been published concerning losses in high-speed gearing for which the authority is not known by the writer. Tests at Schenectady have shown losses about double those generally estimated, with rapid diminution of efficiency as load falls. These tests were of a most accurate character with large smooth running gears and by the motor-generator method where losses alone were measured, the same power being transmitted with and without the gearing.

With the electric drive in these battle cruisers, the losses from turbines to propeller shaft at full speed will amount to 7 per cent, and by adjustment of voltage the transmission efficiency can be kept equally good at all speeds. Considering gearing losses, reversing turbine losses, losses incident to necessary subdivisions of the turbine and additional packings it is believed that the actual transmission from turbine blades to shaft at full speed cannot be made more than 2 per cent better in the geared equipment than it is in the electric. At reduced loads the geared equipment will be much less

efficient. The normal cruising speed of these ships will require less than one-tenth of full load, and the drag of gearing, bearings, reversing turbines and idle parts of main turbines will be very serious.

CRUISING ECONOMY

With the electric design, the number of motors and turbines used can be adapted to the demand for power, while with the other all parts must be kept running. This gives very important gain in economy at all speeds below the maximum. At 19 knots only one turbine is required to drive the ship, and electrical arrangements are made by which it can be run at full speed instead of running at half speed, as it would if the ratio was fixed as by gearing. Thus the steam efficiency at 19 knots, a desirable cruising speed, is equal to the best attainable at any speed. Assertions which have been made by ship builders and others that equal cruising results can be obtained by the use of cruising turbines are obviously absurd. The cruising turbines themselves would be greatly inferior to the single main turbine so used, and they would be burdened with all the drags which are mentioned above. Cruising economy gives increased cruising radius without renewal of fuel supply. This has always been considered a matter of the greatest importance in warships; it is a feature in respect to which electric drive can have no rival.

STATE OF DEVELOPMENT AND EXPEDIENCY

Enough has been said to give an idea of the reasons for the use of electricity in such ships, but in addition it should be considered that everything used in such an electric installation is a matter of exact knowledge and wide experience, while methods of gearing on such a scale are backed by little and brief experience and are the subject of wide difference of opinion as to methods of design and proportions.

The writer believes that the differences of weight and cost which have been predicted by shipbuilders and others are not based upon just comparisons, but that even if they are true they are not sufficient to balance the practical merits of electric drive for such vessels.

For these reasons it is believed that when prejudices are overcome electricity will develop an extensive use in large high-power warships. In such light vessels as scouts and destroyers, for reasons of weight and space, it is relatively much less desirable, but even in such cases with the lightest and most compact designs, and with very high pressure and superheat, it might in the future develop a legitimate application. In merchant ships also it may afford great advantages. With electricity, turbine units can be installed in duplicate, either in single or twin-screw ships. Machinery can be installed where convenient with motors near propellers and turbines near boilers, auxiliaries can be driven electrically from the main units. The highest superheat can be used without danger or complication, and main units can be applied to other power uses such as cargo pumping or handling. These advantages have led to the preference of electric drive at a higher price in certain large freighters recently ordered, and will doubtless lead to many other applications in ships of various types.

The advantages here mentioned have been developed with a wonderful skill and foresight by the Swedish engineer Ljungstrom in the 900-hp. ship Mjolner, which has been in successful operation for about two years. This vessel has shown a fuel economy decidedly superior to anything produced elsewhere in a steamship, and has maintained this high standard throughout her period of service. Such a result with such small power is very remarkable and significant. The Mjolner uses an extremely high degree of superheat.

HALFORD ERICKSON

"In the interest of equal justice it is absolutely necessary in rate-making to give due consideration to the question of rising prices. The failure to do this has forced at least one commission to repeatedly raise rates which under increasing costs had become too low."

Problems in Rate Regulation Accentuated by Higher Operating Costs

BY HALFORD ERICKSON

Of Hagenah & Erickson, formerly Chairman Wisconsin Railroad Commission

IT is now generally recognized that in some form governmental regulation of railways and public utilities generally is here to stay. This idea is considerably strengthened by the fact that, as is already apparent to many, such regulation is about as necessary where such utilities are owned and operated by the public as when they are owned by private persons. Whether the regulation that is thus likely to prevail is the present form or some other form is not so clear.

Regulation deals mostly with questions that are of an economic nature. These questions depend upon and are affected by circumstances which vary greatly from time to time and which are often very complicated. In order to avoid injustice they must often receive prompt attention and firm treatment. The administrative acts involved in passing upon them are subject to much effective criticism from many who have neither the time nor inclination to master the facts and conditions upon which the decisions are based. While the utility commissions have shown marked desire to do justice to all concerned and have done a great deal of good, their work is often affected by so many circumstances that there are times when it is almost impossible for them to decide matters as promptly and to give as full weight to all the facts and conditions involved as equal justice to all would demand. There are many examples in point, as experience shows.

One of these examples relates to the effect upon the rates or the net earnings of railways and other public utilities of the increases that have taken place during the past two decades in the prices of the labor, material and capital which enter into the cost of the service which such utilities furnish. These rises in prices greatly increase the cost of such service, and make it exceedingly difficult to fix future rates thereon. Ex-

perience also indicates that these difficulties have proved too great to be fully overcome. For instance, many rates made by commissions during the past decade or more have been found to be too low soon after they were put into effect. Whether the reason for this is found in the fact that due consideration was not given to the effect of rising prices upon the cost of the service, or to the fact that to have made the rates high enough would have been unpopular, or to both, may be an open question. These advances in prices have, in fact, created some of the most perplexing problems which confront those who are making rates for the future. It is to point this out that the present article was prepared.

REGULATING SERVICE AND RATES

Regulation as it is now known relates mostly to the quality of the service rendered by the utilities and to the fairness of the rates charged for such service. The laws usually require that the service must be adequate and the rates reasonable. What constitutes adequate service is largely a question of engineering facts which can, as a rule, be established and applied with a fair degree of accuracy. This is also true of such changes in the service rules as may be necessary from time to time. Yet just service rules are not always easily applied and readily accepted.

The question of what constitutes reasonable rates, on the other hand, is much more complicated. While such rates have been defined as rates which, under normal conditions, will yield sufficient returns to cover reasonable allowances for the operating expenses, depreciation and interest and profit on the investment, the facts involved in determining such rates are often so uncertain and variable as to be difficult to ascertain and correctly apply.

Rate schedules are likely to be affected by practically all the conditions which affect the industrial and commercial situation generally. A reasonable rate is therefore not only difficult to establish in the first instance, but such rates when once made may require frequent and equally difficult readjustments. Downward revisions are popular, but upward revisions are, as a rule, very unpopular, even when necessary for the good of the service. As rate-making bodies depend very largely upon the good will of the public it is only natural that they should hesitate in raising rates, even when such raises would be just.

TROUBLE IN RATE-MAKING

It is upon the rate-making side of regulation that commissions are thus likely to encounter the most trouble. In the industrial and commercial world neither price nor rates can remain the same very long. Frequent changes therein become necessary because of changing conditions, and these changes are often far-reaching in their effect. Since changes in the upward direction are very unpopular, particularly in the utility field, commissions are often slow in authorizing the same. This is even true in cases where delay in this respect tends to harm the service and cause capital to be withheld from the utility field. The situation in practically all branches of the transportation industry seems to furnish a telling example of this. The reason why the prevailing rates of transportation have of late years yielded less than fair returns is mainly found in the fact that the price of practically everything that enters into the cost of transportation has increased at the rate of from 2 to more than 3 per cent a year.

The cost of railway and other utility service depends entirely upon the amounts that have to be paid for the labor, material, capital, and the enterprisers involved. The cost of labor and material of all kinds enters directly into the construction and the operating expenses. Changes in the prices of these factors are therefore felt or noticed almost immediately after they are made. The costs of capital and of the enterpriser, on the other hand, are indirect burdens, and while they are as much a part of the total cost of the service as any other expense, the changes therein are not always as clearly shown as is the case of the direct expenses. Increases in the cost of capital are first felt in the new capital that is needed. That this should be the case is only natural, since the charges on much of the capital already invested are fixed and do not vary until the securities mature and the question of refunding is raised.

When the prices of the factors of production are thus rising from year to year it also inevitably follows that the cost of the service is increasing. This is particularly true of the total cost. It is also true of the cost per unit of service, except perhaps in cases where the service is rapidly growing in volume, and where, besides this, the plant has so much unused capacity as to be able to meet this growth without extensive additions to the investment.

BASING RATES ON PAST COSTS

Rates made by commissions are usually based on present and past cost. When the prices of the factors of production, or of labor, material and capital remain about the same from year to year past costs, if judiciously applied, are also an important factor in the basis for rates. In periods of rapidly rising prices, however, such as during the past twenty years, rates based on past cost will usually be found to be too low soon after they have gone into effect. Examples of this are numerous. In the railway and utility service, for instance, rates, which a few years ago were regarded as fair, are now yielding returns that are too low to adequately cover the cost of all the factors of production. Many rates, based on past and existing costs, made by commissions during the past decade, have also turned out to be unremunerative shortly after they were put to a trial. Of the rates which have thus been found to yield less than reasonable returns, some have been raised while others again have been permitted to stand at their old level. Such advances as have thus far been made in rates that were too low, however, have come about very slowly. They have not always been granted as promptly as was necessary to prevent serious losses to the utilities or the roads.

Most industrial enterprises have been able to meet the rising prices or increased cost of production by establishing higher prices on what they have to sell. Where this is the case the producers may not have suffered through the change in prices. It is even possible that it may have made many better rather than worse off. Railways and other public utilities, however, have not been in position to follow this practice. They have not only been unable to raise the prices of the services they render in proportion to the increases in prices on what they must buy, but their rates to-day are in many instances actually lower than they were when the present upward turn in the general price level was first noticed.

COURSE OF GENERAL PRICES

Owing to their importance in this connection it is thought proper to herein present a few of the leading facts which indicate in a general way the course of the general price level, and the tendencies of the rates of transportation and of other utility service, as well as the trend of the purchasing power of the average receipts per unit of such services during the past decade or more. In addition to this, facts showing the trend in the cost of labor and the cost of capital are also given.

Table I shows the average receipts per ton per mile for freight transportation; the approximate receipts per 1000 cu. ft. of gas and per kilowatt-hour in some of the very largest gas and electric plants, together with the percentages by which the rates for each prior year exceeded the rates for 1914. It also shows the index numbers which represent the course of wholesale prices and the per cent by which the prices in 1914 exceeded the prices for each preceding year.

Table II shows the course of the purchasing power of the average receipts per unit of service, as given in Table I, together with the percentage by which the purchasing powers for the preceding years exceeded those for 1914.

While these tables explain themselves a few points concerning them may be mentioned. The average receipts per unit of service were much higher in 1897-98 than they were in 1914. The percentages of these excesses amounted to 9.02 per cent for freight, 43.9 per cent for gas and 319.04 per cent for electrical energy. For the remaining years the excesses over 1914 show smaller percentages. For wholesale prices, on the other hand, the course is in the opposite direction. The prices in 1914, for instance, were 48.88 per cent higher than in 1897.

The effect of this downward trend in the rates and upward trend in general prices upon the purchasing power of the receipts per unit of service has been tremendous. The amount that could be purchased by the earnings per unit was much greater in 1898 than in 1914. In fact, it exceeded that of the latter year by 51.13 per cent in the case of freight rates, by 108.19 per cent in the case of gas rates, and by 506.41 per cent in the case of the rates for electric energy.

Prices at the mines on coal for fuel or power were 44.5 per cent higher in 1914 than in 1897.

On all sorts of supplies and material such as are used by railways and utilities the prices were from 20 per cent to more than 60 per cent higher in 1914 than in 1897.

The average daily wage in the railway service was about 47.9 per cent higher in 1914 than in 1897. These relations appear to hold good for other utilities as well. In 1914 the average rate was 22.2 per cent higher than in 1905. Since 1914 there have been important increases in the rates of wages in almost all occupations.

The cost at which capital can be had depends very largely upon the risks involved, the course or state of general prices, and the demand for capital.

COST OF CAPITAL

Close studies of the cost of capital during the past fifteen years or more indicate quite clearly:

That on safe bonds, that is bonds that are protected by property and net earnings that amount to about twice as much as the principal and the charges for interest thereon, the cost of capital was about 4 per cent from 1900 to 1907, when it rose to about 4½ per cent. In 1909 this cost rose to about 5 per cent; in 1913 it advanced to more than 5 per cent and has remained at about this figure ever since.

That on stocks which do not amount to much more than the difference between the par value of the bonds by which the stock is thus preceded and the full value of the property and equities of the plant, and which stock is also protected by a net income thereon for dividends and for surplus for risks and contingencies that amounts to from 50 per cent to 100 per cent more than the 6 per cent which is usually demanded in dividends, the cost of obtaining capital is about 10 per cent, or about twice as much as the cost of that part of the capital which was had on the bonds. The higher returns which are thus demanded on the stock as compared with the bonds represent the compensation which the investors in stock require for the extra risks to the investment, and for the responsibilities and work involved in connection with the management of the plants which the stockholders have to assume.

These are in substance the terms upon which investors, under normal conditions, are willing to furnish capital. They are also in the main the conditions and terms with which those who desire to obtain capital must comply. They indicate that on the first one-half or, say, 65 per cent of the investment which is represented by bonds the cost of the capital is something more than 5 per cent, while on the balance of the investment which is represented by stocks the cost of the capital is not far from 10 per cent. In order to meet these costs it is therefore necessary that a utility should earn at least 7 per cent on the fair value of the prop-

Decline in Purchasing Power Accompanies Decline in Rates

TABLE I—COURSE OF FREIGHT RATES AND GAS AND ELECTRICITY RATES IN SOME OF THE LARGEST PLANTS

Years	Tons One Mile		Gas Per 1000 Cubic Feet		Electricity per Kilowatt-Hour		Wholesale Prices	
	Cents per Ton per Mile	Per Cent by Which Prior Years Exceed 1915	Average Receipts 1000 Cu. Ft.	Per Cent by Which Prior Years Exceed 1914	Average Receipts per Kilowatt-Hour, Cents	Per Cent by Which Prior Years Exceed 1914	Index Number Average 1890 to 1899 Equals 100	Per Cent by Which 1914 Exceeds Prior Years
1897	.798	9.02	.....	.....	.....	.....	90	48.88
1898	.753	2.86	$1.18	43.90	8.8	319.04	93	44.08
1899	.724	1.10*	1.16	41.46	8.5	304.76	102	31.37
1900	.729	.41*	1.21	47.56	8.1	285.71	111	20.72
1901	.750	2.46	1.24	51.21	7.8	271.42	109	22.93
1902	.757	3.41	1.22	48.78	7.1	238.09	113	18.58
1903	.763	4.23	1.16	41.46	6.7	219.04	114	17.54
1904	.780	6.55	1.09	32.92	6.3	200.00	113	18.58
1905	.766	4.64	1.08	31.70	5.8	176.19	116	15.51
1906	.748	2.19	.88	7.31	4.0	90.47	123	8.94
1907	.759	3.69	.82	.....	3.1	47.61	130	3.07
1908	.754	3.01	.84	2.43	2.7	28.57	123	8.94
1909	.763	4.23	.84	2.43	2.4	14.28	127	5.51
1910	753	2.87	.85	3.65	2.2	4.76	132	1.51
1911	.757	3.41	.84	2.43	2.2	4.76	129	3.87
1912	.744	1.64	.81	1.23*	2.2	4.76	134	.....
1913	.729	.41*	.82	.....	2.1	.....	135	.74*
1914	.733	.14	.82	.....	2.1	.....	134	.....
1915	.732	.....	.....	.....	.....	.....	.....	.....

*Decrease.

TABLE II—COURSE OF THE PURCHASING POWER OF RECEIPTS PER UNIT OF SERVICE

Yeras	Receipts per Ton per Mile		Receipts per 1000 Cubic Feet Gas		Receipts per Kilowatt-Hour	
	Purchasing Power	Per Cent by Which Prior Years Exceed 1914	Purchasing Power	Per Cent by Which Prior Years Exceed 1914	Purchasing Power	Per Cent by Which Prior Years Exceed 1914
1897	846	75.15	.....	.....	.....	.....
1898	730	51.13	127	108.19	946	506.41
1899	608	25.87	114	86.88	833	433.97
1900	569	17.80	109	78.68	729	367.30
1901	615	27.32	114	86.88	715	358.33
1902	606	25.46	108	77.04	628	302.56
1903	610	26.29	101	65.57	587	276.28
1904	639	32.29	97	59.01	557	257.05
1905	597	23.60	94	54.09	500	220.51
1906	539	11.59	71	16.39	325	108.33
1907	524	8.48	63	3.27	238	52.56
1908	550	13.87	68	11.47	219	40.38
1909	549	13.66	66	8.19	189	21.15
1910	512	6.00	64	4.91	166	6.41
1911	530	9.73	65	6.55	171	9.61
1912	491	1.65	60	1.66*	164	5.12
1913	467	3.42*	61	.....	155	.64*
1914	483	.....	61	.....	156	.....

*Decrease.

erty and equities of the plant. When these rules are deviated from it appears to be mostly for special reasons which apply to particular cases only.

The Purely Investment Enterprise

The facts as to prices which affect the cost of the service have thus been given in some detail in order to emphasize their importance to the rate-maker, and in order also to point to the injuries that may result from failures to adequately consider the same in fixing rates for the future. This applies as much to increases in the cost of capital as to increases in the cost of labor and material. The terms and conditions upon which capital can be had, however, are perhaps less well understood than the prices on the other factors, but are nevertheless as real as any part of the cost of the service. These terms, as stated above, have been laid down by the investors themselves. They are based upon experience as to what is necessary in the way of protection and earnings in order to place the securities on an investment basis. The investor thus appears to hold that there should be a fairly close relation between the capitalization, on the one hand, and the value of the property and business which it represents, on the other; that in order to avoid receiverships in hard times and under adverse conditions in other respects the bonds should not greatly exceed one-half of the valuation of the plant; that risk and responsibilities are an element of cost and should be largely borne by the stockholders; that the extra risk and responsibilities which the stockholders must thus assume should be offset by greater returns upon their part of the investment; that on such investment securities as those outlined above the cost of capital is at least 5 per cent on that part which is represented by the bonds and about twice as much for that part which is represented by the stocks; that of these returns on the stock about 6 per cent must be paid as dividends while the balance above this represents a surplus that is required for safety and for contingencies to be used for the benefit of the stockholders as an additional compensation for the risks they must bear on their investment and for the responsibilities they must assume for the management and the service; and that securities which are less well protected by property and income than those which come under the above rules are speculative rather than investment propositions, and must therefore be dealt with on other bases than those outlined.

Great Increase in Cost of Capital

The cost of the capital obtained on such investment securities as those described thus appears to have advanced from 20 per cent to 35 per cent during the past decade or more. The ratio of the advance in this case is about the same as the ratios of increase in the prices of labor and material during the same period. That investors, when discovering that the purchasing power of their principal is declining at a rate of from 2 to 3 per cent a year should, as a partial offset to this loss, demand higher rates of interest on their investments is only what should be expected.

The returns and earnings thereon which are thus demanded by the investors, plus such commissions and certain other expenses as may be connected with the sale and issuance of the securities, thus represent the cost of the capital. This cost from an economic point of view is as much a part of the cost of the service as the amounts paid for the labor and material which enter into such service. It is a cost which, like the operating expenses proper, must in the end be borne by the customers if the service is to be furnished.

In studying the price advances that have thus taken place it is found that trust-controlled and tariff-protected articles have risen no faster than articles subject to competition and articles on the free list. Other causes of increasing prices than the trusts and tariff must therefore be looked for. It is possible that the gradual using up of our natural resources is partly responsible for the rise. It is even likely that the growing scarcity or higher cost of many raw materials may have resulted in even greater advances in prices than those which have actually taken place had not this growing scarcity been, at least partly, offset by greatly improved methods of production. The most important causes of the rising prices, however, must be traced to the great increases in gold production that have taken place during the past twenty-five years, and to the great improvements in our credit facilities that have been developed during the same period. The dollars have not only increased in number more rapidly than the growth in business, but each dollar is now doing much more work than formerly.

The effects of such increases in prices have been varied as well as far-reaching. In the railway field, for instance, as well as for other utilities, the effect of these rises in prices and of the failure of the rates charged for the service to keep up with the advances on everything that enters into the cost of the service has often resulted in increasing the proportion of the operating expenses to the gross revenues by as much as from 15 per cent to 40 per cent, thus leaving a proportion for fixed charges that is constantly growing smaller.

Reaching the Limits of Efficiency

These increases in the proportion of the operating expenses to the gross earnings would have been much greater even than the figures given had not the managements of the utilities exerted themselves to the utmost in increasing the efficiencies of operation. While through such efforts much of the increasing cost has been offset the economies resulting therefrom have now about reached their limits. Prices, however, other than railway and utility rates keep on climbing. They are now higher than at any other time during the past three or four decades.

If all prices rose or fell at the same time and to about the same extent no one would either lose or gain through such changes. The experience is, however, that price changes are irregular both as to time and amount. In consequence of this those are gainers who happen to receive high prices for what they have to sell and to pay low prices for what they must buy, while those are losers who have to sell cheap and buy dear. The gains and losses from such sources are often great and very far-reaching in their effect. For it is obvious that when the money income fails to grow as rapidly as the rises in prices of those things which must be purchased with such money income, serious financial embarrassments are almost certain to follow.

Those who are so situated that they have been able to offset the increased costs of what they buy by higher prices on what they sell have, of course, been in position to bear the rises in the prices in question without losses. Those, on the other hand, who like railways and public utilities generally have not been permitted to raise the prices on the services they render have often found their net earnings badly shrinking and their financial position much weakened. In many cases this trend for the worse has reached such a stage as to alarm the investor and make it exceedingly difficult to obtain new capital for much needed additional facilities and for expansions of the service. A situation like this not only retards the necessary development of the utilities themselves and deprives people of much needed service, but it has a bad effect upon industrial and commercial conditions generally. A policy or practice of

which this must be said is clearly contrary to public interest.

That such increases in prices and cost as the country has had to face during the past twenty years must receive serious consideration from the rate-maker if trouble is to be avoided is now clear beyond dispute. Under such rises in prices it is certainly not often safe to base future rates on past cost, as has been the common practice in the past. With prices increasing at the rate of from 2 to 3 per cent per year it is obvious that past costs must be lower than future costs, and that for this reason rates based on past cost will also be too low for future requirements. That this is the case has been clearly shown by past experience in these matters. When instances are met where the costs per unit of service have not been increased by higher general prices, it is probably because of the fact that these utilities were so happily situated as to have been benefited by the law of increasing returns. But even in such cases the evil day is only postponed. For as soon as the existing facilities are exhausted and new facilities on a larger scale have to be provided it will be found that the law of increasing returns is operating from a higher level and that the existing rates are likely to be too low.

These facts certainly indicate that in the interest of equal justice it is absolutely necessary in rate-making to give due consideration to the question of rising prices. The failure to do this has forced at least one commission to repeatedly raise rates which under increasing costs had become too low. Many of the rates so raised had been put in by the commission itself, and most of these rates were, when so put in, based on existing cost with little or nothing above this in the way of margins for contingencies. If rates, when thus found to be too low, were promptly readjusted as soon as the need for it was discovered, the injustice inflicted by the error would not be as great. But owing very largely to the bitter opposition that is usually stirred up against such increases, the advances in the rates which justice thus requires are often postponed from time to time regardless of the fact that these delays are proving very costly and unfair to the utilities.

SHORTCOMINGS TO BE REMEDIED

These facts also show what a delicate and difficult task proper rate-making really is; and that while cost is an important factor in rate-making, the cost that should be considered in this connection is not the past cost alone, but rather the past cost modified by probable future changes therein. To determine the fair cost and the fair rate under such circumstances is exceedingly difficult, and yet it must not be shirked if regulation is to be in line with public interest. The importance of this is readily seen when we remember that a large proportion of all the really valid objections that have thus far been raised against the regulation of rates seem to be based upon orders in which commissions have provided rates which were barely high enough to cover past costs, and which therefore left no margins for such increases therein as were almost continually brought about through advancing prices. These and certain other shortcomings in connection with regulation have resulted in many inequalities as between the interests involved. They have also caused many investors to withhold new capital for new and much needed extensions to the plant and in the service it rendered. Whether these shortcomings can be remedied would seem to largely depend upon the makeup of the commissions, and upon whether the commissions will be placed in such a position that, like the courts, they can do justice to all concerned without fear of being unduly interfered with.

PETER JUNKERSFELD

"Central stations in general have grasped a fine opportunity to strengthen their position as regards power load in the last year. . . Continued growth from the same source may be expected in at least the first half of 1917."

The Sale of Electric Service in Larger Quantities

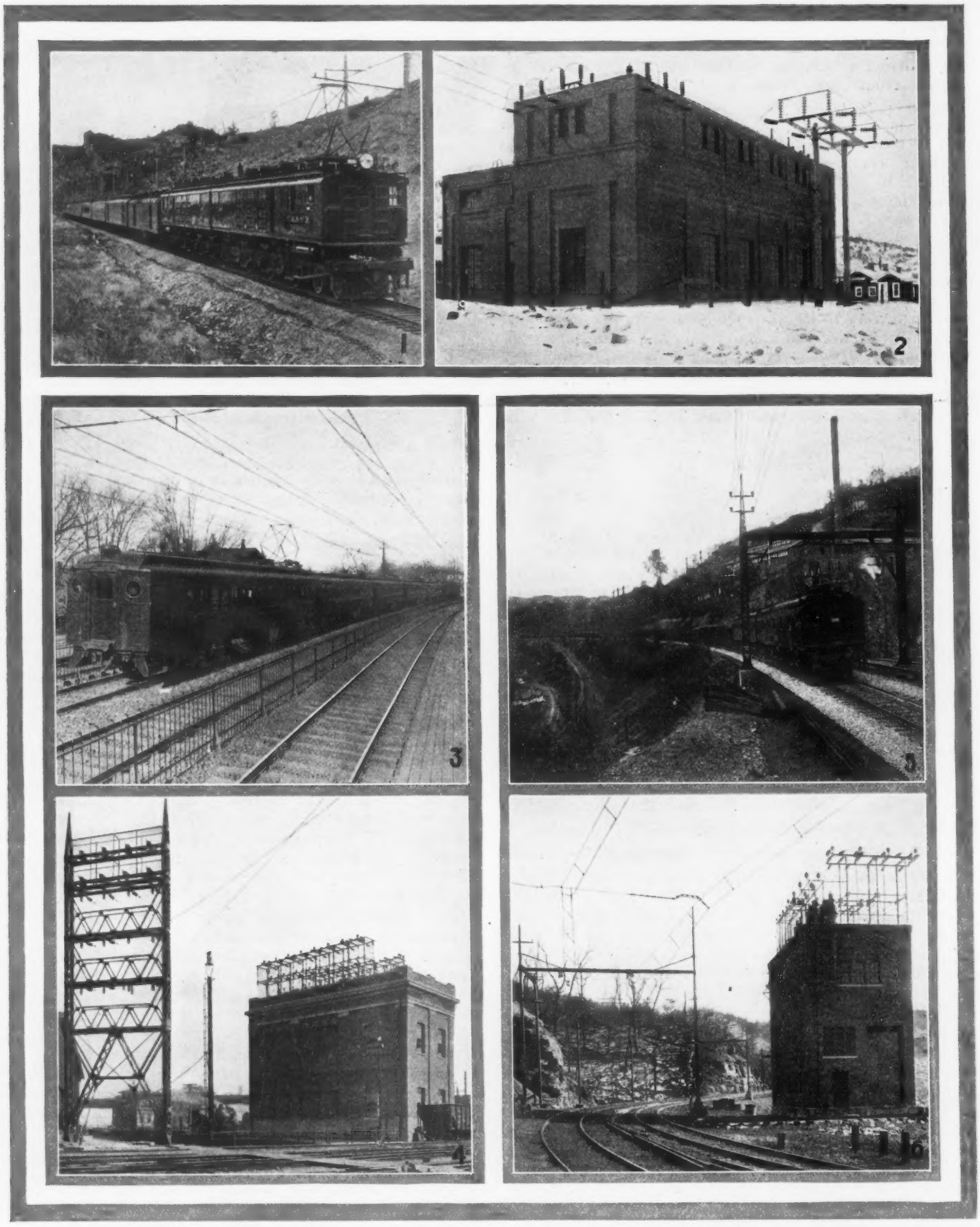
BY PETER JUNKERSFELD

President Association of Edison Illuminating Companies

AMERICA'S enormous industrial expansion in 1916 and the marked advance in general commodity prices have been and still are responsible for an almost unprecedented epoch of growth in the central station industry. The reasons underlying this situation, in its relation to electricity supply companies, are quite easily understood. First, the 1915 stimulation of practically all American manufactures created a demand for an immediate increase in power facilities. The manufacturer who was using central station power and operating his factory below its normal output, quickly secured additional power; there was then a resultant increase in his energy consumption. The manufacturer who was not so doing found in casting about for a solution of his power problem that prices of equipment were going up and found deliveries in an unreliable state. He also found labor scarce and increasing in price. But in his consideration of central station power he found service for his full requirements almost immediately available at a staple price, the trend of which has been constantly downward. His choice, therefore, could hardly be other than for central station power.

This solution of the power problem, therefore, contributed largely to the growth in central station sales. In addition to this the increase in manufacturing and the need for greater safety and higher efficiency all called for more electric light in the factory; the establishment of better merchandising methods also required the liberal use of electric light in more commercial establishments, and better living resulted in the use of electric light and of electric appliances in more homes.

As yet what is perhaps the full extent of this growth has not manifested itself in the energy output records; a great volume of business now contracted for, but not connected, will not begin to be active until the first half of the coming year. In that period the true con-



1.—The fast transcontinental passenger train "Olympian" in Silver Bow Canyon, drawn by electric locomotives of the Chicago, Milwaukee & St. Paul Railway. Electrified service was started on this division early in 1916.

2.—Substation at Janney, Mont., on electrified division of the Chicago, Milwaukee & St. Paul, which receives energy from the system of the Montana Power Company.

3.—Electric train on Philadelphia-Paoli section of the Pennsylvania Railroad, handling suburban service out of Philadelphia. Ths section was electrified late in 1915.

4.—Stepdown substation at West Philadelphia and supporting tower for 44,000 volt incoming lines and outgoing 11,000 volt trolley feeders for the Philadelphia-Paoli electrified section. This substation receives single-phase energy from the New Christian Street generating station of the Philadelphia Electric Company.

5.—270-ton locomotive hauling freight on the Norfolk & Western Railroad near Coalville, W. Va., showing steam station of Appalachian Power Company in the background. The Norfolk & Western will shortly tie in with this station at the Maybury substation near by. The system was electrified in 1914-1915.

6.—Maybury substation, which receives 44,000-volt single phase energy from the Bluestone Junction generating station of the Norfolk & Western Railroad, and transforms it to 11,000 volts for trolley service

Steam Road Electrifications that Employ Central Station Service

dition should begin to be reflected on the output records. To illustrate this point several central station companies in the Eastern and Middle Western States have contracted for twice as much new power business in 1916 as they did in 1915, and a few of them for about three times as much.

RAILWAY POWER APPLICATIONS

Among the spectacular developments in the field of electricity supply is the broader application of central station power in passenger and freight transportation. Railway companies which formerly generated a part or all of their electrical energy are from year to year purchasing a larger portion of their power from central station companies. The economies resulting from specialization and massed power production in a single territory are beginning to be much better understood by all parties interested; the business of transportation is to distribute people and goods; the business of electricity supply is to distribute electricity for every purpose. So at the end of 1916 we find central stations supplying direct current or alternating current, either single-phase or three-phase, for urban and interurban electric railways, for steam railway terminals or trunk lines in any quantities desired. These loads are taken regardless of their size or their intermittent characteristics, all with great advantage to the communities in which such central stations operate.

The total amount of electrical energy required for terminal electrification while large is not as large as commonly supposed. In the Chicago district even the quite ambitious plan reported on early in the year by a committee of the Chicago Association of Commerce, under which all freight and passenger traffic would be moved electrically on 3500 miles of single track, was estimated at 532,000,000 kw.-hr. per annum with a yearly maximum demand of about 125,000 kw. For convenience in comparison it may be said that the electrical energy used in 1916 for surface and elevated railroads in the same area was 736,000,000 kw.-hr., and it is estimated will be about 1,100,000,000 kw.-hr. in 1927. Even if all the electrification reported on by the above mentioned committee were in operation in 1927, the probability of which is very remote, the ratio of steam railway terminal energy requirements to local electric railway requirements would be on the order of one to two. The ratio is likely to be less than one to two, and in smaller railway centers the ratio would be much less.

The successful operation during the year of the St. Paul electrification in Montana and of the Pennsylvania Railroad terminal in Philadelphia, both supplied with central station power, has been especially noteworthy. The St. Paul now terms its electric locomotive "King of the Rails," and advertises to the public its many proven advantages. The accumulated experience with electrified terminals and the largely increased business of the steam railroads, and consequent need for more intensive and efficient use of some of their terminals and trackage, points more definitely than ever before to electrification as an early solution. Only a few weeks ago the Illinois Central Railroad has, in negotiation with the City of Chicago, offered to electrify its terminal and suburban service within five years.

ELECTROCHEMICAL AND ELECTROMETALLURGICAL APPLICATIONS

The year has been particularly marked by a phenomenal expansion of the electrochemical and electrometallurgical industries due largely to the increased domestic demand resulting from the feverish activity of industries which can no longer import materials from abroad. At the same time the power situation at Niagara Falls has become so acute that many of the electrochemical industries located there have not only been unable to expand in response to the increased demand for their products, but have actually been compelled to curtail their production.

This power shortage at Niagara Falls has resulted in the establishment of several plants for manufacturing electrolytic alkalies and chlorine in other parts of the United States. Before the war the manufacture of electrolytic alkalies was limited by the amount of by-product chlorine which could be sold. This condition is now reversed, as there is a very large market for chlorine for bleaching purposes and for use in chlorination in several industries. At the same time development work is being done in the electrolytic manufacture of chlorates and perchlorates, while hypochlorites for bleaching purposes are already being made on a small scale.

The Great Western Electrochemical Company is building a plant at Pittsburgh, Cal., which will employ 2500 hp. supplied by the Great Western Power Company, for the manufacture of alkali and chlorine. The output will be about 5000 tons of caustic soda and 10,000 tons of bleach annually. The electrolytic production of hydrogen and oxygen has expanded greatly during the year. New plants for this purpose have been built in Boston and in Quincy, Mass., and elsewhere. Over 300,000,000 cu. ft. of hydrogen per year is now being generated in the United States.

The various processes for the fixation of atmospheric nitrogen have naturally experienced a greatly increased application because of the use of nitrogen in explosives. The total installed capacity of the cyanamide, arc, and synthetic ammonia processes, expressed in tons of nitrogen per year, increased from 92,240 tons in 1913 to 298,910 tons on Jan. 1, 1916, or more than 200 per cent. About 1,000,000 hp. is used in this industry. Practically none of the development has taken place in the United States, although an American cyanamide plant on the Canadian side at Niagara Falls has experienced a considerable expansion.

Electrolytic processes for the production of organic compounds have been worked out in the laboratory, but for the most part have not yet become commercial. Among other substances which can be prepared in this manner are the "intermediates" used in the manufacture of coal-tar dyes. The electrolytic process has certain very pronounced advantages and, in view of the present expansion of the American dye industry, further developments along this line are to be expected.

ELECTRIC STEEL FURNACE

One feature of present tendencies in electrometallurgical development is worthy of special notice. Electrical processes are gaining ground rapidly in every industry where the prevention of waste or the production of an article of exceptional quality has become of prime importance. When the demand for steel exceeds the supply and junk piles are searched for available metal, the electric steel furnace experiences a boom because it is capable of making an excellent quality of steel from a comparatively poor quality of iron and steel scrap. Electric steel castings command a premium for work in which unusual durability and resistance to stress are required. As a more and more careful conservation of our resources becomes necessary, as our standards of quality become higher and the specifications for the products of industry become more exacting, electrical processes steadily gain ground because of their greater economy in the use of raw materials and the improved quality of their products.

On Jan. 1, 1916, there were approximately seventy-three electric steel furnaces operating in the United

States, producing at a rate of perhaps 100,000 tons per year.

Although complete figures for 1916 are not yet available, it seems that the number of electric furnaces in operation has been doubled and that their present output probably exceeds 1,000,000 tons per year. The United States now has more electric steel furnaces in operation than any other country. These furnaces require in the neighborhood of 150,000 hp. Among the largest single installations under way are the addition of one 15-ton and two 20-ton Heroult furnaces at the South Chicago plant of the Illinois Steel Company to the one 15-ton furnace already in operation there. Most of the furnaces installed are employed in making castings, using scrap as a raw material, but a few are used for making ingots from Bessemer or cupola metal.

Electric Lighting and General Power Applications

While the present and possible future sales of electric service for such special applications as the foregoing are extremely important, it must be remembered that they are only available for such central station companies as operate in present or prospective industrial centers. Moreover, these special applications are all in a stage of rapid development, and, therefore, in large part susceptible of many further changes which may affect the stability and permanency of the sale of electric service for such purposes. It is probably of greater importance to the central station industry that more intensive work be done toward developing the less spectacular but more stable business of electric lighting, general power and sale of power to electric railways and to other public utilities.

An analysis of the income accounts of even large central stations in industrial centers indicates that more than half of the revenue results from electric lighting, particularly commercial lighting. The saturation of residence lighting is surprisingly low, in many cases only one family out of four or five being supplied with electric lighting, and a much lesser number with electric appliances. In one well-known instance the revenue from the four principal classes of business in 1916 was as follows: Residence lighting, 18 per cent; commercial lighting, 37 per cent; power for general and industrial purposes, 22 per cent; power for railway purposes, 23 per cent. The saturation or percentage served of possible business is highest on power for urban railway purposes and lowest for residential purposes. The street lighting is furnished from a municipal plant. The power for railway purposes was all the power used and to be used in that community until railroad terminals are electrified. The service for residential purposes had only reached the point of supplying one family out of three. Even in this central station, with its highly developed railway and power business and no street lighting, 55 per cent of revenue was due to electric lighting. In the average central station this percentage is much higher and electric lighting correspondingly more important.

And so to sum up the situation, it would appear that central stations in general have grasped a fine opportunity to strengthen their position as regards power load in the last year. They are awake to the situation, and continued growth from the same source may be expected in at least the first half of 1917.

There is also evidence of a better appreciation of electric lighting as a revenue producer, particularly from existing mains. It would seem very important during the coming year that central stations should not neglect the study and development of lighting and better illumination because in that field large and real possibilities still exist.

DR. W. R. WHITNEY

"The contributions of pure research are seldom in response to recognized needs, but the needs themselves are developed or disclosed through the research."

The Great Need of Promoting Research in America

By Dr. W. R. Whitney

Director of the Research Laboratory, General Electric Company

If we had a movie film of the growth of our American nation from the beginning, and this were speeded up so that we could see our history reviewed at a rate where general trends became visible, one peculiar thing would appear very clearly. It would look as though we were going to the dogs at a rapid rate. At first the land is covered with forests and filled with game. Rapidly the trees are cut down and burned, and the game disappears. Grass and grains sweep across the country from East to West, in a wondrous growth, but almost as quickly the growth deteriorates and abandoned farms appear. The people rapidly increase in numbers. They crowd together. Holes are dug into the rock and all the coal is removed. Through other holes all the oil and gas is quickly drawn. A few little water-wheels turn around in isolated spots and help to feed countless little lights which rapidly appear in all parts of the country. A lot of wood- and coal-burning apparatus goes whizzing across the land, to be followed in feverish haste by rapidly augmenting myriads of other automatic devices, consuming the oil and gasoline. Everyone knows the fertility cannot last. Everyone sees that the wood, coal, and oil will go only a little farther, and nobody worries.

Run at high speed, the film shows that great numbers of the people die too quickly, and many of them from identical and simple diseases. It seems as though the thing ought to be stopped and this defect remedied before it goes farther. A few such readjustments have evidently been made before. It isn't entirely clear from the film that changes in happiness are taking place at all, and yet the general rapidity of change and energy consumption seems always increasing. Nowhere does the mental level seem to rise. A most marked peculiarity is the mechanical or engineering force which is quickly turning all knowledge into apparatus, and now, as we wonder how the film can long continue, it stops, and leaves the rest to us. At the beginning of a new year it seems to me more fitting that we should think

of the future than review even with satisfaction the accomplishments of the past.

UTILIZING THE WORLD'S KNOWLEDGE

Coincident with our history, other countries, somewhat differing from our own, have been increasing the world's store of knowledge by a certain system. It is by utilizing this store that we have made most of our advances. From it we have made our engines, healed our wounds and cured our sick, talked through wires, and heard through infinite space. We inventors and engineers, using, generally, the scientific products of foreign lands, have turned knowledge into utility. But we have taken no time to contribute to the world's needed supply of new facts. We owe a debt we hope our descendants will pay. We might as well defy them to pay it.

Compared with other countries, we have been exceedingly shortsighted. We are much more active as users than as producers of knowledge. We make no provision for repairing the rapid exhaustion of our soils, replacing our disappearing coal and oil, nor providing the new knowledge on which future life or happiness must be based. Inventors and engineers are being rapidly grown, but searchers to unearth the knowledge on which engineering is based are not being produced. In medicine there are hundreds of thousands of engineers (practising physicians), but only a few research men. All of the former use diphtheria antitoxin, for example, and save the lives of thousands of children. This is possible because there was a certain research carried out by a trained man who did not have to be an engineer in order to live. Certainly tuberculosis and cancer call for experiments to help the engineering physician. He simply cannot efficiently perform the necessary researches and be the engineer too. Other countries have provided for the education, support, and encouragement of men who practically devoted their lives to pure or scientific research. Their investigations seemed more or less academic. These were careful physical analyses of natural phenomena which, at the time, had no visible utilitarian value. As we look into the lives of these pioneers, we find that they were usually much like keenly interested but highly intelligent boys in their appreciation of Nature. They were always learning, and spreading their information broadcast. By some public plan they were immune from the interruptions of conflicting cares, and could pursue their studies uninterrupted. It is not surprising to find that most of the foundations of engineering, whether they be antitoxins or ether vibrations, have come to us through professors of science in European universities or institutions.

TEACHING SECONDARY TO RESEARCH

As we review the history of scores of such cases, it is evident that most foreign universities have held teaching to be secondary to research and have, for several decades, at least, employed and given great facilities to men who made experiments their life work and taught science for the purpose of preparing similar investigators. It is we Americans who have prostituted teaching for the use of the industries.

In a volume on German culture edited by a group of English writers, there are comparative lists of great contributors to engineering science. There are listed twelve leaders in chemistry and twelve in physics from England, France, Germany, and the rest of the world, making ninety-six in all. They were the producers of new science in the nineteenth century. Of these ninety-six, only five were from the United States. Forty-eight mathematicians are also compared, and no American is among them. In other words, from a scientific point of view, we represented about 3 per cent of the world's constructive gray matter.

Another and different criterion occurs in the recipients of the Nobel prizes. These are annually awarded, without regard to country, to the individual who is most deserving in the particular fields of physics, chemistry, physiology or medicine, literature, and peace. Here again we do not shine very brightly. In physiology or medicine, among the thirteen awards down to 1914, America had received one. Also in physics, the United States had received one out of thirteen, and in chemistry none. That is, in new and constructive scientific work of this kind during these recent years, America had been recognized only twice out of thirty-nine chances—again a value so small as possibly to be attributed to error of observation.

WE FAIL TO LAY FOUNDATIONS

While we may be doing our share in the applications of science, we have failed in laying foundations. This is thoroughly deprecated in J. J. Carty's recent presidential address before the American Institute of Electrical Engineers. Until we can learn to do still better, let us follow the example of the German universities or of the British institutions. There the teaching of science is not confined to the preparation of men to earn a living as engineers. In practically every one of scores of universities, particularly in Germany, there are professors whose main object seems to be to advance knowledge, to discover new facts, and to teach by precept the acquirement, instead of the storage of information. They work with their own hands. The very great value of these professors is seldom realized, and so I want to call to mind a few of them. There is no end to the possible list, and I will consider more or less connected lines of endeavor, so as to maintain some semblance of order. The point I wish to make is that apparently most of our advances may be traced back to one of these professors, who, trained to be an observer, matured in a laboratory supported by the state, has had time and facilities to follow the lead of some natural observation.

RESEARCH DISCLOSES NEEDS

Consider electric lighting, for example. The earliest impetus was given to it by experiments using the cells of Grove and Bunsen. They were famous for their research and teaching as well. One was a professor in England, the other in Germany. The publications on these batteries at the time show the men to have made careful and interested studies of novel phenomena. Of course they had no thought of electric lights, and even when these were produced by battery currents much as pocket lamps are to-day, there was no commercial development until the current generating machines were produced. But even with the cells of Grove, Sir Humphry Davy produced the first electric arc between carbon electrodes. Davy was for many years the chief chemist and lecturer of the Royal Institution. If we go back of Grove or Bunsen, we come to the professors of Boulogna and Pavia, who made the first researches on current generation. Galvani investigated the frog's legs and Volta the metal pile. They published their observations. Fundamental observations and the necessary experiments are always more certain to be performed by such trained observers than by others. Faraday, the life-long investigator of the Royal Institution, had disclosed the principles of the generation of electric current by using permanent magnets, and further research then became rapid. Apparently Professor Wheatstone made the first machine for producing current by mechanical means without permanent magnets, though Siemens presented his paper to the Royal So-

ciety first and both were read before the society the same evening. In either case the product came from the kind of mind and the type of study which I am showing contributes to our knowledge. The contributions of pure research are seldom in response to recognized needs, but the needs themselves are developed or disclosed through the research.

The more recent history of lighting is filled with the studies of engineers and students, and greatest of these is Edison, but even here one cannot help noting the radical or unexpected steps whose foundations are laid in the professor's laboratory. An entirely new type of electric illuminant was disclosed by Professor Nernst by his studies of oxide conduction. Dr. Welsbach, in rare oxide investigations, not only found the gas mantle, but produced the osmium incandescent lamp as well. Von Bolton, student of Ostwald and highly trained in experiments, worked out tantalum and produced a new lamp, and even the recent tungsten gas lamps depend on the purely scientific researches of the able English professors, Rayleigh and Ramsay, for the argon used in them.

The Invisible End of Observation

Readers of *Popular Mechanics* some time ago selected by vote the seven wonders of the modern world. The highest votes were received by wireless, the telephone, aeroplane, radium, antiseptics, antitoxins, spectrum analysis, and X-rays. How were these originated? All of them were produced by the identical formula. In the first place, they were not the result of a direct attempt to accomplish what was really attained. The end was not visible when the foundations were laid. The real work was done by thoroughly well-trained observers—not by laymen. They were professors in every case. They followed up a lead opened by an observation which was too insignificant to attract the attention of less trained men.

It would be impracticable to give the histories of these so-called wonders. Anyone who reads may learn how Professor Helmholtz, an expert German investigator, was the instigator of the work of Hertz, which in turn was based on the principle of Maxwell that variation in elective displacement is electric current. This, Maxwell had derived from work on Faraday's researches. And thus, in the foundations of the single wonder of wireless, we find the co-operating efforts of at least four experimenting professors of science. They were all working for the public and supported by a university or public institution.

Radium and X-rays are of so recent disclosure that it is hardly necessary to recall that the work was done by English, German, and French professors.

Another interesting international grouping of the typical kind of thoroughly high grade workers in science, all professors, is found in the experiments on antiseptics. Professor Lister, of England, is usually considered the leader in this line, but he thanked Pasteur for giving him "the only principle which could have conducted the antiseptic system to a successful issue." Koch, in Germany, advanced the line on which Pasteur was at work, and discovered the bacillus of tuberculosis, while Tyndall, another of the men of the Royal Institution, finally laid at rest the related question of spontaneous generation.

Federal Appropriations Should Promote Research

One might well conclude from the history of the British Royal Institution alone that pure research was a good governmental investment if the environment was capable of developing such products as Davy, Faraday, Tyndall, and Rayleigh. Surely we may hope to awaken ourselves to the importance of constructive action for the advancement of science. If we count only on on such private bequests as have already helped so much in studies of disease, we are evidently not awake. Federal appropriations to assist American colleges in research seem a fair way to discover and produce good men and to economically supply them with apparatus and atmosphere.

DR. E. F. ROEBER

"It is not yet sufficiently appreciated how intimately the products of the electrochemical industries enter into the daily life of everyone. . . The electrochemical industries are absolutely needed in the industrial life of this country."

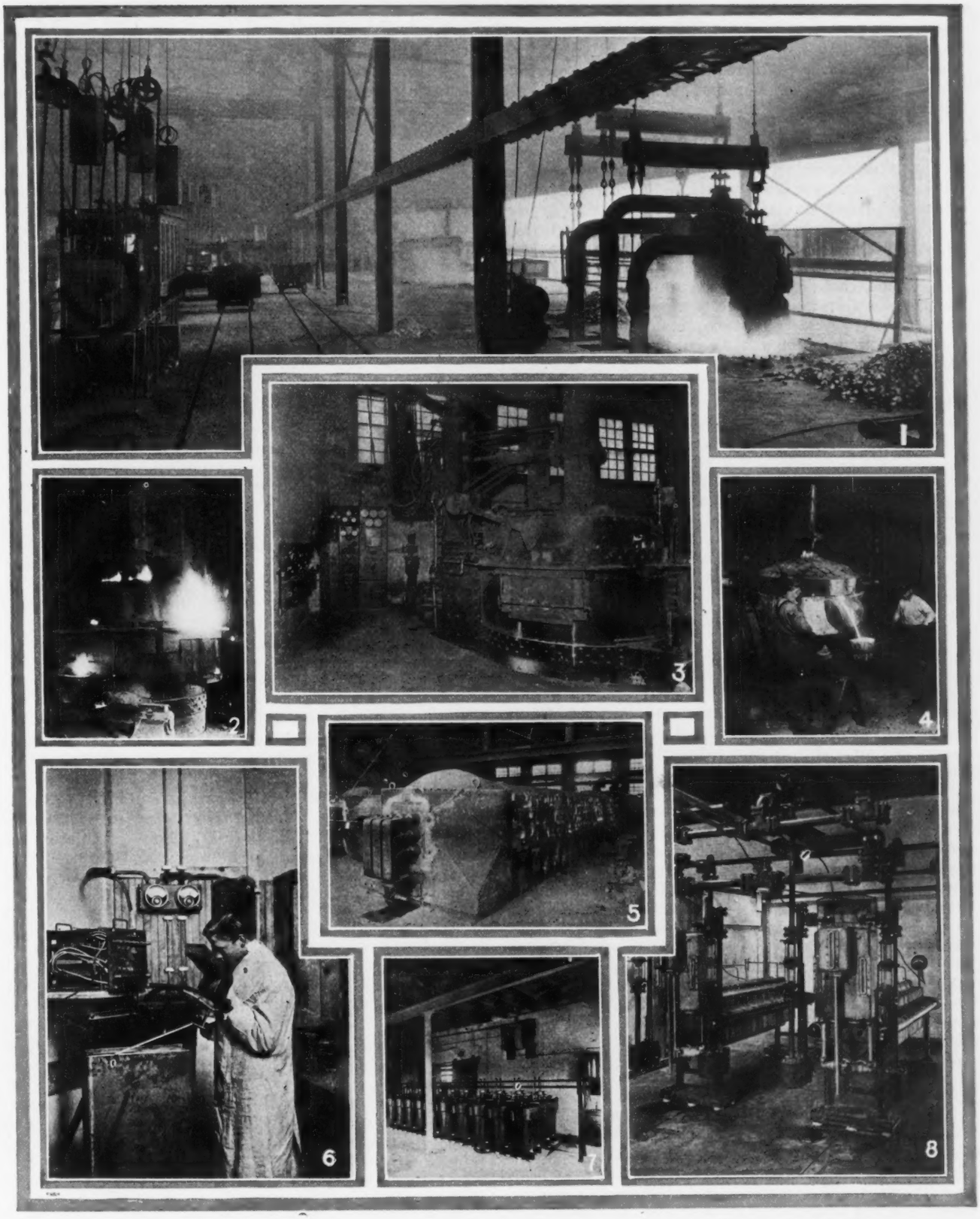
The Future Opportunities for American Electrochemistry

By Dr. E. F. Roeber

Editor *Metallurgical and Chemical Engineering.*

During 1916 the electrochemical industries of the United States have been extraordinarily active and prosperous. But in one respect at least a limit of their development has been reached in so far as all the power at present available at Niagara for electrochemical purposes is now utilized and no further increase of electrochemical plant capacity on the American side of Niagara is possible, unless Congress acts.

Naturally the prosperity which the electrochemical industries of this country have enjoyed has been part of the general industrial activity and has been closely related to the international trade conditions brought about by the European war. The direct effect of the war has been especially manifest in the steel industry. The heavy consumption of alloy steels formerly made largely by the crucible process has greatly favored the rapid progress of the electric steel furnace, the decisive economic advantage being the much larger capacity of the furnace unit over the crucible; if the year 1915 saw a doubling of electric steel furnaces in America, the progress in 1916 has been at the same rate and new electric steel furnaces have been erected all over the country. Again this heavy production of alloy steels has resulted in a greatly increased demand for ferro-alloys, and this has been accentuated by the shutting-off of imports since the start of the war. At the outbreak of the war about one-half of the domestic ferrosilicon consumption was imported, but now practically all ferrosilicon needed for consumption is manufactured here, and a small amount is exported. Three



1.—One of eight 2400-kva. carbide furnaces used by American Cyanamid Company in its Niagara Falls plant, which uses central station energy.

2.—One-ton three-phase Heroult furnace operated from system of Edison Electric Illuminating Company of Lebanon, Pa.

3.—Three-ton three-phase electric furnace operated from system of Detroit Edison Company.

4.—200-kw. single-phase furnace installed at North Tonawanda, N. Y., and operated from system of Cataract Power & Conduit Co.

5.—Electric furnace of Acheson Graphite Company, operated on Niagara Falls energy.

6.—Welding tank with slag-vapor arc at plant of Automatic Weighing Machine Company, Newark, N. J., which is supplied with central station service.

7.—Unit type oxy-hydrogen generators rated at 3.2 cu. ft. of oxygen per hour with 0.85 kw. continuous demand.

8.—Bipolar-type oxy-hydrogen generators forming part of International Oxygen Company installation at Newark, N. J., rated at 140 cu. ft. of oxygen per hour with 36 kw. continuous demand.

Attractive Electrometallurgical and Electrochemical Loads for Central Stations

new manufacturers of ferrosilicon started production during the past year, and to provide part of the needed furnace capacity a calcium carbide plant in Niagara was switched over to ferrosilicon manufacture. Similar activity has been manifest in the manufacture of other ferro-alloys.

Dependent on Electrochemical Industries

But it would be wrong to think that "war orders" were chiefly responsible for the activity of the electrochemical industries. It is not yet sufficiently appreciated how intimately the products of the electrochemical industries enter into the daily life of everyone—artificial abrasives, graphite, bleaching powder for water purification, caustic soda for soap making, calcium carbide for lighting and oxy-acetylene welding, electrolytic copper for electric conductors, aluminum for kitchen utensils, automobiles, and so on infinitely. Only one strikingly specific example may be quoted. At the Chemical Exposition in the Grand Central Palace in New York in September, 1916, the American Electrochemical Society exhibited in its booth an automobile chassis showing by means of placards what a large part electrochemical products played in its manufacture—"Niagara Made Detroit Possible." As Mr. F. J. Tone has pointed out, it is no exaggeration to say that if the automobile manufacturer was now deprived of artificial abrasives (made in the electric furnace) and compelled to go back to the grind stone and at the same time we took away the other products of Niagara power, aluminum, oxy-acetylene welding, and high-speed steel, an automobile factory that now produces 500 cars per day would be reduced to an output of 100 cars per day with the same plant and the same workmen and the cost would be correspondingly increased. In fact, there would be no automobile industry on its present existing lines.

The electrochemical industries are absolutely needed in the industrial life of this country. Concentrated as they have been in the past chiefly at Niagara Falls and having reached there the limit of their development, along what lines may we expect future developments to proceed? We will leave out of consideration electrolytic copper refining, which has developed along independent lines with centralization near New York Harbor, and likewise the problem of fixation of atmospheric nitrogen so important both for the fertilizer industry in peace time and the explosive industry in war time; but as this problem is closely allied with the program of national defense, the best location of plant rests on other considerations than those of ordinary industrial geography. We will restrict our remarks to the question: How may we expect the electrochemical industries which have centered so far in Niagara to expand in future?

Further Expansion

The new steam plant of the Buffalo General Electric Company will provide some relief to a limited extent. Then other water powers in other parts of the country will be utilized as they have been during the past year. Keokuk now has a ferrosilicon and other electrochemical plants. Great Falls, Mont., has now its electrolytic zinc plant, and the new electrolytic zinc plant at the Mammoth smelter in Shasta County will get its current from Northern California water power, while a new caustic soda and chlorine plant on the Bay of San Francisco is supplied with energy from the Great Western Power Company. All these are promising and highly interesting developments. But it must not be overlooked that the abundant water powers of the Pacific Coast cannot compete in most electrochemical products with Niagara Falls in the Eastern market on account of prohibitive freight rates. The Pacific Coast must look for its own markets either in the Pacific Coast States or in export trade West and South.

The question then remains: What chances have the electric central stations all over the country in the future development of electrochemistry? It is evident at once that for large-scale developments, as at Niagara, most central stations have not sufficient continuous power available. Most of the Niagara electrochemical industries could not well be operated intermittently; even in most cases where it would be technically possible it would be unsound economic policy, since very often the investment in electrochemical plant is higher than the investment in the electric power plant so that more interest would be lost in leaving the electrochemical plant idle at times than would be saved by keeping the power plant fully loaded continuously. But granting the strength of this argument, there remains enough that could be undertaken successfully by central stations

Electric Steel Furnace Progress

The progress of the electric steel furnace is perhaps the most instructive example in point. There are now quite a number of central stations supplying current for steel refining or for making steel castings, with results very satisfactory both to the steel maker and the central station. The cost of electric energy is by no means of greatest importance in the cost sheet so that a very low power rate is not necessary. On the other hand, at least in times of normal activity, it could be arranged to operate the electric steel furnace only at hours of light load in the central station, so that it would be possible to fill out the valleys in the load curve and quote a lower power rate. In parentheses it may be remarked with respect to the selection of the furnace type that three-phase and in a few cases two-phase furnaces have been installed almost exclusively for the production of alloy-steel ingots, while in the field of steel castings the high-power single-phase furnace has made considerable progress.

When a fool-proof electric furnace for brass melting becomes available, it should prove likewise a very attractive load for central stations. This is a matter to which central stations in the New England States might profitably pay some attention.

Electrolytic Processes

Among electrolytic processes which have proven valuable loads for central stations we may mention only two. One is the electrolysis of water for the production of oxygen and hydrogen for oxyhydrogen welding and cutting. There are quite a number of such plants now in existence, especially along the Pacific Coast. The second example is the production of hypochlorite solution (bleaching liquor) by electrolysis of brine for laundry uses.

Finally, if the electrochemical plant is located near the central station, the availability of exhaust steam for evaporating purposes is an attractive asset for many purposes.

The Central Station Opportunity

In any case, to what particular field of electrochemistry an electric central station might pay special attention will depend on local conditions. Highly progressive central stations like the Commonwealth Edison Company of Chicago and the Detroit Edison Company, which are going out for an electrochemical load, are proceeding along such logical lines. In locations where there is a steel industry the electric steel furnace is the thing to push, in localities with paper and pulp mills the manufacture of chlorine and caustic soda, and so on.

But after everything is said as to what can be done by the electric central station in creating an electrochemical load, it is evident that the Niagara power problem cannot be solved in that way. Electrochemical industries have already begun to emigrate from this country to Canada and Norway. If this country is to keep unimpaired its electrochemical industries, the only solution is further development of Niagara waterpower, and this requires the courageous action of an enlightened Congress.

EDWARD N. HURLEY

"The manufacturers of electrical supplies should not only work out cost accounting systems for themselves, but should also work out such a system for the retailer. . . The business man who cannot afford to know his costs cannot afford to risk his capital by remaining in business."

The Constructive Movement for Scientific Cost Accounting

BY EDWARD N. HURLEY
Chairman Federal Trade Commission

DEVELOPMENTS in the last year have materially strengthened the conviction that sound cost accounting principles are vital to business; and in the coming year the Federal Trade Commission will extend its efforts to impress upon business men of every class the immeasurable importance of facing the facts of cost. It has seen substantial progress in the movement to disseminate information on this subject and a constructive interest which promises to yield satisfactory and lasting results.

The earnest manner in which the question is being approached by many industries throughout the country is a clear indication that business will be on a better plane, a safer one for the banker and investor and the only possible firm basis for a permanent individual organization and the largest measure of reward for labor.

It is the purpose of the commission to make its aim definite and to give constructive aid to organizations of business men on this fundamental question. Arrangements are now being made by the commission with the Institute of Public Accountants to approve a uniform set of rules in conformity with which chartered accountants will henceforth make reports. When the commission takes final action upon this matter it will refer the questions involved to the Federal Reserve Board and if that department of the government should co-operate favorably the outcome will be of far-reaching importance.

CO-OPERATION BY GOVERNMENTAL AGENCIES

It would mean that this country will have two governmental bodies which will be firmly committed to the principle that conservative, illuminating accounting is a necessary protective measure in business. A strong, co-operative attitude on the part of these governmental agencies will not only be of material assistance to the chartered accountants in their work, but it will also be a guide-post for manufacturers by supporting standards for the various industries. This will assure the condition that competitors in a given industry will follow a standard method under which a uniform plan will be followed for the treatment of depreciation, depletion, obsolescence and other items which are so vital to any industry and this will tend to make prices more uniform.

A GREAT EDUCATIONAL CAMPAIGN

What the commission has done, is now doing and hopes to do in the future is to conduct an educational campaign the fruits of which will extend to every industry. Our plan, if we can persuade Congress to grant the necessary appropriation of $100,000 especially for cost accounting purposes, is to divide the country into zones corresponding to the Reserve Bank zones. The subject would then be taken up by representatives of the commission in the different zones in connection with trade associations, trade papers and other groups of business men—retailers, wholesalers and manufacturers.

The work which the commission can do in this direction has really been given a preliminary start by the booklets on cost, of which 350,000 have now been distributed. It is significant of the real interest in this reform that it was not necessary to send these booklets to lists of those whom it was thought would be interested but that they have received this large circulation as the result of individual requests received by the commission. So thoroughly have different sections of the country and different industries been represented in these requests that we are asking Congress to meet the cost of an additional issue of 500,000 of the booklets.

NEEDS OF THE ELECTRICAL INDUSTRY

In every step of this nature the electrical industry has a profound interest. Through its trade associations the industry is taking hold of the problem, recognizing it as a real economic one of great importance. These associations realize that the large motive of the commission is to aid them in creating a strong foundation below the frost line upon which the superstructure of business may rest in safety.

Having a particular personal interest in the electrical business I feel keenly the position of the different elements of this industry upon this question. On account of the rapid growth of the industry and the fact that it leans for support upon many patents it has not in the past paid as much attention as it might have done to details of costs, etc. In later years competition has become more keen, and since provision was not made in the early days for careful attention to the matter of cost accounting it is most important that the various companies should work together now in those respects in which they may legally co-operate.

MANUFACTURERS SHOULD HELP RETAILERS

I think that the manufacturers of electrical supplies should take a personal interest in the retailer and

should not only work out cost accounting systems for themselves, but should also work out such a system for the retailer. Cost accounting in the organization of the manufacturer alone without such a system in the distributer's operations will render the entire movement ineffectual.

The manufacturers should promote joint action by themselves and the retailers. If they look beyond the immediate problems of their own factories they will be able, in co-operation with retail dealers, to protect the industry against the inefficiency which comes from disregard of costs. If the small retailer will be efficient he will be a permanent influence in the electrical industry. But it is necessary for him to swim if he is not to sink and in learning to keep up he will require friendly guidance.

Expense of Cost Accounting

One general criticism of cost accounting systems is that they are too expensive to install and continue. This criticism is heard less frequently in times like the present. Indeed, the very prosperity which leads people to think less of the expense involved in such systems is forcing them for their own protection to study costs with the greatest care. It is therefore an ideal moment for agitating the importance of the subject. The business man who cannot afford to know his costs cannot afford to risk his capital by remaining in business. Under the conditions of the last year business men found that increased volume did not always mean increased profits. They know that every item costs more and that generally they are not making the same percentage of profit that they did two or three years ago but unless they analyze costs they are not able to place their fingers exactly on the reasons why this is so.

Of National Importance

Scientific cost accounting will have so profound an effect upon our commercial operations that it should be regarded as a movement of far-reaching national importance. But in order that it may be in this position the various industries and sections of the various industries will have to do much intensive work in their own fields. If they will follow the recommendations of the Federal Trade Commission they will gain a reward in better business methods which will richly repay all effort. These recommendations, however, mean a radical change in the methods of so many business men that they are likely to be effective throughout the country only after a long educational campaign shall demonstrate their usefulness.

International Conditions

Developments in the international situation indicate that a return to normal conditions in the world at large is nearer. When peace is declared I think that a natural reaction from our tremendous industrial pace will follow for a few months. Since the output of our factories is sold for six months ahead the purchasing power of labor will not be affected much while this condition lasts.

Our present momentum is so strong that in my judgment the reaction will be only temporary and it will be followed by a new period of activity resulting from European reconstruction. Not only the belligerent countries but also other nations, such as those of South America, will buy freely when the tension is relaxed and uncertainty gives way to certainty and confidence. While this activity continues and new conditions of European competition are crystallizing this country will be tested and it should not delay the introduction of progressive movements which will assist it in the world-wide contest for commerce.

DR. A. E. KENNELLY

"What is needed in education for national development in America is trained foremen as well as engineers. . . By opening up fundamental economic laws in simple and logical terms to all who propose to be foremen of industry, a vast amount of misconception, suspicion and intolerance would be swept away."

The Relation of Engineering Education to National Development

By Dr. A. E. Kennelly
Professor of Electrical Engineering, Harvard University

In the primitive stage of national development represented in sparse Colonial settlement and widely-separated farms the functions of engineering are necessarily restricted to improving highways, telegraphs and means of communication. This was the condition of American life in the seventeenth century. Such a condition may be economically stable and capable of being perpetuated indefinitely, but the growth of population, aided by natural emigration to where land can be had for the asking, inevitably leads to the formation of cities and of industrial communities. The need for engineering and for the education of new engineers then rises with leaps and bounds. Whereas on the primitive farm, for example, each family works its own well, in the city the well must give place to waterworks of a very expensive type. It is necessary not only that these works should be erected under the direction of engineers, whose skill and knowledge shall be utilized to save all unnecessary expense in the process, but also that there shall be specialists developed among engineers who shall devote themselves particularly to the study of water and waterworks from physical, mathematical, chemical, structural and economic standpoints. It is to the development of this highly specialized training and knowledge among water-distribution engineers that we may hope for future improvements, developments and economies in the constantly expanding engineering problems of supplying water to large communities.

In the same way, as the density of population increases, the need for large-scale operations increases also in every branch of industry and production. This calls for more expenditure of aggregated capital and for more intelligence, experience and knowledge in directing the work. This, in turn, means more engineers and more engineering training. It also means more specialties and specializing among engineers. In

the days of Moses engineering was a well-recognized calling among the ancient Egyptians; but subdivision or specializing among them seems to have been almost unknown. As a class, they were confined to the priesthood. Any one engineer could take up the work of any other. At the present time there are perhaps fifty branches of engineering, with yet more numerous twigs or minor subdivisions, so that while the fundamental training of all is the same the special occupations and experiences vary so greatly that those in one branch know but little of the doings of other branches, and they cannot immediately take up each other's tasks.

It is therefore reasonable to expect that as time goes on there will be more density of population, more intensive construction and production and more engineering and education of engineers. The danger of overproduction of young engineering graduates by the colleges is at present insignificant. There is always more demand for good men than there is supply. The excess of the needs for young men who have received a college engineering training in the ranks of the profession is eagerly absorbed in manufacturing industries. This does not mean that there are large emoluments awaiting all young engineering graduates any more than in the other professions and walks of life. Education can develop, but it can no more create ability in the professions than in the arts, and only those should enter a profession who have some natural ability in the kind of occupation it offers. It should mean, however, that there is opportunity for energy and ability in a number of branches of engineering and particularly for those who have had a good special preparatory education.

What is needed, however, in education for national development in America at the present time is trained foremen as well as engineers. For one trained and experienced engineer we need perhaps twenty trained and experienced foremen to execute and conduct the work which the engineers are able to plan and direct. It is not enough to have the trained officers for the army of industry. There must also be enough trained non-commissioned officers and trained men in increasing ratio. Moreover, the opportunity must always be open for trained men to develop into foremen, and for trained foremen to develop into engineers. At present we have more than a hundred engineering schools in America engaged in training engineers. We have relatively only a few engaged in training foremen. It is as unreasonable to expect that foremen can be adequately trained in the field or factory alone as that engineers can be adequately trained in the field or factory alone. Such field or factory training is indeed indispensable and constitutes experience. But experience alone, without study and mental training, can only produce adequately competent engineers or foremen in the relatively few cases of natural gifts and natural energy sufficient to impel private study and individual mental hard work.

What is needed then is a greatly expanded system of vocational schooling for young men and women in which to study the elementary principles of their vocations before taking these up entirely as experience and economic support. The expense of this vocational training can be largely recouped by the industrial results of the system, with its output of foremen and specially trained workers.

What is also needed in the vocation schools is a teaching not only of the elementary scientific principles of machinery and production, but also of the elementary economic principles underlying the same. It is almost self-evident that the fundamental laws of economics regarding production and distribution are as simple and as rigorous as those of mechanics or of electricity. To a large proportion of the industrial world these fundamental economic laws are a sealed book. By opening up these laws in simple and logical terms to all who propose to be foremen of industry, a vast amount of misconception, suspicion and intolerance would be swept away. Economic fallacies breed apace and may create more human misery than earthquakes.

PRESTON S. MILLAR

"Scientifically, artistically and commercially there is reason to believe that artificial lighting is at the beginning of an important period of development."

The Outlook in Illumination at an Important Period of Development

BY PRESTON S. MILLAR
General Manager Electrical Testing Laboratories

ONE HUNDRED years ago artificial light cost per unit about twenty times as much as at present. Furthermore, it was practically impossible to secure adequate illumination indoors because of the excess of smoke and fumes which would be produced by tallow dips and whale oil lamps which were generally used in all but luxurious practice in this country.

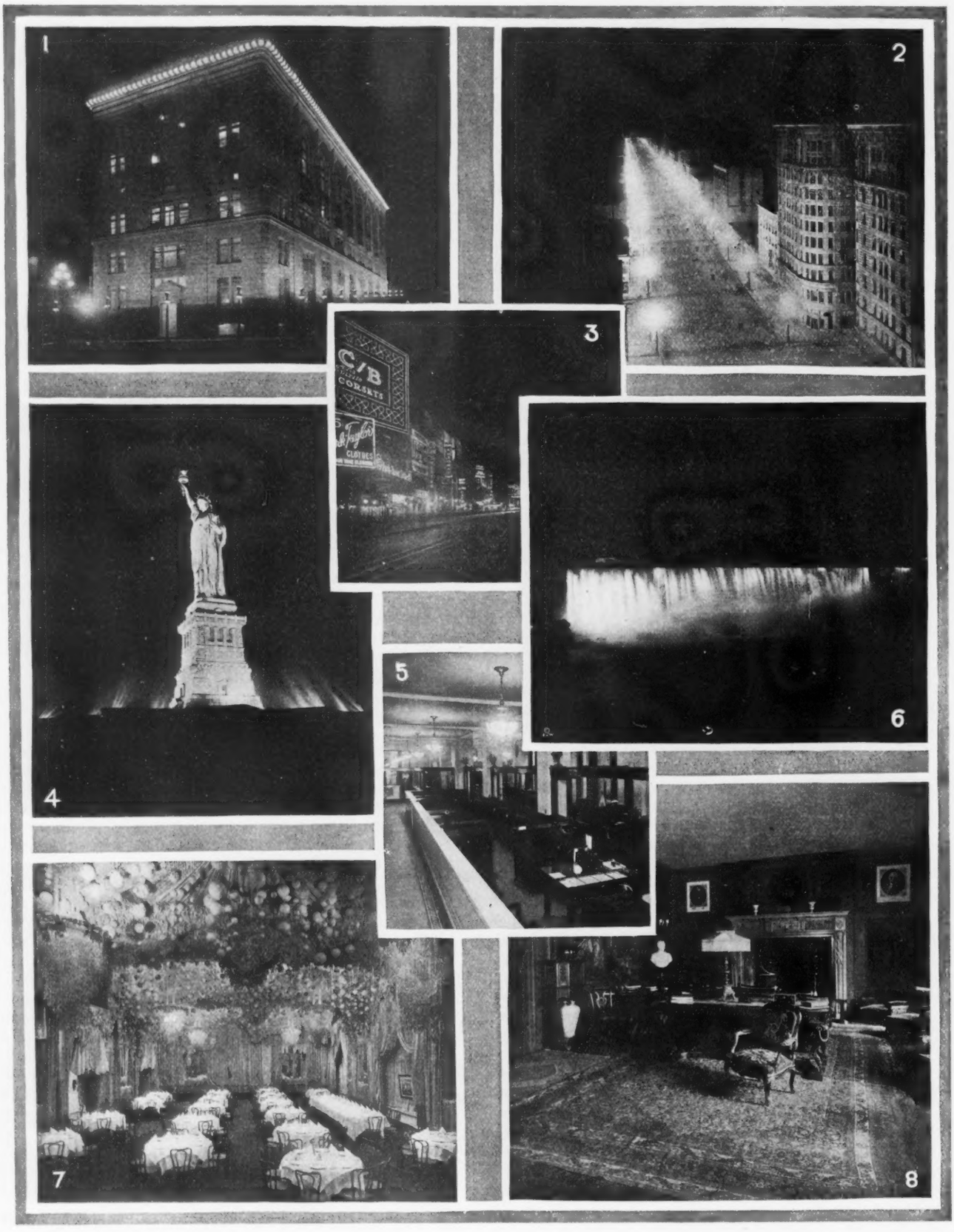
Modern illuminants of higher efficiency supplied with cheaper energy or fuel make available in all but the humbler rural buildings ample light without deleterious vitiation of the atmosphere or other objectionable effects. Progress, especially during the last few decades, has been so great that one may be tempted to believe that most of the improvement to be obtained through artificial lighting has been achieved and that developments of the near future are apt to be less marked.

Likewise when one contemplates man's nocturnal activities, whether they be industrial or recreational, he may be inclined to think that further extensions will be of modest limit because so much of the possible ground has been covered.

What are the possibilities?

LIGHT SOURCES

It is difficult to believe that the production of artificial light will not advance in efficiency materially beyond the present low attainment. At the same time, as far as general information is concerned, no radical advance is in sight. It is possible that when the next radical step in improvement of light efficiency is made, the result may be of a character which does not render the new light source practicable for ordinary use. The public has become accustomed to a degree of simplicity and convenience in the use of light sources which can-



1.—A Seattle (Wash.) office building flood-lighted from curb standards.

2.—Salt Lake City's new ornamental street lighting.

3.—New York's ever-glittering Great White Way of Broadway signs.

4.—Liberty, permanently flood-lighted.

5.—"Daylight" lamps used in office illumination.

6.—Niagara bathed in tungsten sunshine of its own making.

7.—Spectacular lighting effects in a Los Angeles restaurant, secured by mixture of indirect lighting of primary hues.

8.—In home interiors the tendency is toward table portables and shaded bracket lamps.

A Year of Lighting Achievement Traced in Pictures

not be thoughtlessly sacrificed for a gain in efficiency of light production. Also, there are fairly definite ideals, and indeed fairly definite requirements as to color of light. To be effective, advance in efficiency of light production must satisfy these other requirements to be capable of general adoption.

Coming to the subject of lamps and their probable development in the very near future, one may anticipate further progress in the substitution of the gas-filled lamps for the vacuum-tungsten lamp; the continuance of the replacement of the older carbon arc lamps by gas-filled incandescent lamps; and the extension of the gas-filled type into smaller sizes.

The need for light of a variety of colors and the awakening of illuminating engineers to the possibilities of the use of colored light are bringing a demand for colored bulb incandescent lamps which may some day result in transferring such modified lamps from the special into the regular classes in spite of the reluctance of all concerned to see increase in the variety of lamps to be manufactured and stocked. The tendency to extend the gas-filled lamps into smaller sizes and the manufacture of concentrated filament vacuum lamps (the latter an objectionable development which seems to have run its course) has brought brightness violations which are objectionable and damaging.

It is probable that the requirements thus imposed for reduction in brightness will lead to the development of diffusing glass bulbs, at least before there is launched a gas-filled lamp smaller in size than the present 75-watt lamp.

INCANDESCENT LAMP PATENTS

The arrangement under which the General Electric Company is licensing existing "independent" small lamp manufacturers, permits them to use the incandescent lamp patents of the General Electric Company. This may increase the advantage which accrues from the general control of the lamp manufacturing situation by one responsible organization. As time passes this advantage is becoming more patent and should continue to bring real advantage to the lighting industry so long as the present disposition to promote the best interests of lighting continues to characterize the policy of the lamp manufacturers.

If there is any impending development in the arc-lamp field it is not a matter of general knowledge at the present time.

LIGHTING ACCESSORIES

Lighting fixtures are divided (not without exception) into two general classes, respectively metal and glass—candelabra and bowls. The fundamental reason for this division is of course traceable to the commercial consideration that the glass manufacturers feature fixtures in which glass is used largely, and the other manufacturers do not. It has been stated to the writer by one who has made a recent examination of the latest products of these kinds that the tendency in the candelabra type of fixture design is toward the use of a multiplicity of small lamps affording protection to the eyes only in that the lamp bulbs are frosted or coated, though occasionally candle shades are attached; and that the tendency in the case of illuminating glassware is toward light direction with more or less complete inclosure of the light source, the directional effect being obtained by the utilization of prisms or enamel or a variety of densities of glass.

REPLACEMENT OF ANTIQUATED FIXTURES

The replacement of antiquated fixtures, which are generally uncouth and which afford little or no protection against glare, by some of the great variety of modern fixtures which are more or less satisfactory in these particulars, proceeds but slowly. It is this problem which constitutes the principal impediment at the present time to the general improvement of lighting throughout the country. The machinery for effecting the replacement in residences particularly, and in some other classes of installations, has not yet been provided.

Here is a duty and an opportunity of which some organization or organizations connected with the lighting industry may avail themselves. Who will obtain the credit for this achievement?

ILLUMINATING ENGINEERING

Colored light has been but little employed in practice. Generally speaking, light has been used in the hues in which it is produced. Where color has been employed, it has been restricted principally to special use, as in theatrical lighting and for festivities and celebrations of a special nature. The wonderful opportunities offered for the artistic employment of colored light to achieve effects which are in themselves capable of application to permanent lighting have not been recognized.

Even in commercial lines where every incentive is present to employ colored light with a view to direct economic advantage, it is not the practice to select light of the color best adapted to the purpose in hand. In considering these simple relations one finds ample opportunity for speculation as to probable developments in the use of colored light without taking into account the relatively unexplored aspects of colored light, for which we must look to the physiologist, the psychologist and the artist for further elucidation.

FLEXIBILITY OF ELECTRIC LIGHTING

There seems reason to believe that in certain classes of installations, alternate lighting equipments offer opportunities for utility and decoration. Electric lighting is so flexible that the public need not be limited to light of one particular quality. Adjustable or exchangeable or alternate lighting systems may be provided. When once it is appreciated that lighting in its several qualities may be adapted to the occasion, a considerable extension in the flexibility of illumination may be anticipated.

The lighted ornament offers a possibility for an extension of artificial lighting which may receive more attention in the near future.

FLOOD-LIGHTING

The gas-filled tungsten lamp with high power and small area light source has been successfully applied in flood lighting in special cases. Here and there a notable building has been illuminated externally at night, or an exposition has been lighted (it may be noted that the Panama-Pacific International Exposition lighting was principally by arc lamps rather than by incandescent lamps as just indicated). The lighting of the Statue of Liberty in New York Harbor and of such buildings as the tower of City Hall, Philadelphia, suggests that in the very near future historical spots throughout the country may be illuminated attractively at night.

Also notable bits of architecture, such as the City Hall, New York, in its setting of modern office buildings, may be revealed at night through the medium of flood lighting. How much farther will this new kind of exterior illumination be carried? May it not be the experience of the near future that flood lighting may be carried much farther than in the mere lighting of occasional notable buildings? May we not anticipate the

lighting of whole streets of notable buildings, thus forming a glorified street-lighting system?

OUTDOOR RECREATION LIGHTING

Outdoor recreation at night is encouraged by the extension of artificial lighting. Already, tennis courts, baseball diamonds, football gridirons, athletic tracks and portions of golf links have been illuminated successfully at night. It would appear reasonable to look forward to extensions of illumination for recreational activities which will make it more generally possible for the public to find suitable opportunity for night recreation of a wholesome sort. With lower rates for power and higher efficiency illuminants now available, we need only an awakening on the part of the public to the low cost at which it is possible to secure the full advantages of artificial light to bring about developments in lighting which will have something of the same advantage which artificial irrigation possesses over natural irrigation; namely, an ample supply wherever, when ever and how ever required for any purpose. Lighting enthusiasts believe that a start in this direction has been made. Must we feel that they are wrong, or may we too anticipate rapid growth in this direction for the very near future?

THE ILLUMINATING ENGINEERING SOCIETY

Probably the strongest single factor operating to improve illuminating conditions is the Illuminating Engineering Society. For ten years it has accumulated knowledge of lighting principles, serving as a forum for the discussion of both principles and practice, and disseminating the information developed through its activities. It is understood that the society is now engaged in organizing a movement designed to afford a trial of the value of good lighting. If success attends its efforts within the next year or two, there may be some definite measure of the practical advantages to be attained through the adoption of really good illumination.

If the facts indicate that industry and economy are promoted, and that commerce is accelerated, we may hope that the appeal of such results will bring about a large improvement in lighting generally through the sheer economic advantage to be obtained. This accomplished, the improvement of lighting where the commercial advantage is lacking may follow from the good example.

PHOTOMETRY

Some of the most important problems in photometry appear to be in a fair way of settlement. The integrating sphere has emerged as the most practical and desirable form of photometer for measuring the light output of illuminants. The scheme of heterochromatic photometry developed by Ives and adopted by the Bureau of Standards seems likely to solve most of the problems of color photometry. The requirement for a simple, inexpensive device for rough measurement of illumination is understood to be in process of satisfaction.

CONCLUSION

Developments in the lighting field proceeded rapidly during the past year. Scientifically, artistically and commercially there is reason to believe that artificial lighting is at the beginning of an important period of development.

In the past the large benefits of improvement in artificial lighting have grown out of advances in light production. Are we not justified in believing that large benefits in the near future will be derived from improvements in the utilization of light?

PROF. W. F. DURAND

"Both capital and labor seek the highest market and no scheme which attempts to provide power or any other product at less than its fair cost can hope to represent a permanent factor in our economic development."

Progress and Outlook in Prime Movers

BY W. F. DURAND
Professor of Mechanical Engineering,
Leland Stanford University, California

THE situation as regards coal and oil fuel for steam power production remains much the same as in recent years, but with a pronounced tendency toward higher prices for oil manifest throughout the year. This has caused serious apprehension on the part of those primarily dependent on oil fuel, regarding the future of the next five or ten years. Boiler plant designs, with special reference to stack proportions and general arrangements have been planned with careful reference to a possible or even probable change to coal fuel within the life of the plant. These are primarily questions of economics and not of engineering difficulties. Either type of fuel can be efficiently handled and the question of use will, in the years to come, be determined solely on the basis of economic advantage.

UTILIZATION OF LOW GRADE COAL

In the meantime the search continues for ways and means of effectively utilizing low grade coal fuels. During the last year pulverized coal has attracted increasing attention as a fuel not only for industrial purposes such as heating billet furnaces, etc., but for power purposes as well. For the most part these studies have been directed toward its utilization as a locomotive fuel, but in a few cases central power stations have been fitted to burn this fuel. One of the largest and most successful of these is at the railroad shops of the Missouri, Kansas & Texas Railroad at Parsons, Kan.

Low grade bituminous and lignite coals are used carrying as high as 20 per cent ash and 30 per cent moisture. For effective burning in pulverized form the coal must be finely ground and dried. The equipment in general thus consists of means for (1) drying, (2) pulverizing, (3) blowing the fuel in the form of dust into the furnace, and (4) special furnace design to protect the tubes and sheets from the high temperatures developed.

The drying should leave the coal with residual moisture not exceeding 0.5 per cent.

To obtain the best results in the furnace the coal should be ground to a degree of fineness which will insure the passage of 95 per cent through a 100 mesh screen and 85 per cent through a 200 mesh screen.

With coal thus prepared and with heating value 11,580 B.t.u., tests have shown an equivalent evaporation of 8.38 lb. per pound of coal fired and of 10.9 lb. per pound of combustible. With Texas lignite with a heating value of 11,250 the results showed 7.26 lb. per pound of coal fired and 8.81 lb. per pound of combustible. The cost of coal dust thus prepared was about $1.795 per ton and of evaporating 1000 lb. of water, on the basis of the first of the tests above noted, was 11.6 cents. These results are significant in high degree and the possibilities of such low grade fuel should receive increasing attention on the part of power plant engineers.

SMOKE ABATEMENT

Smoke abatement continues to receive attention, especially in large cities. A recent report of the Massachusetts Gas & Electric Light Commission, referring to a certain part of the city of Boston shows for the year 1915, violations of the smoke laws for only 1.5 per cent of the observations on power plant chimneys, as compared with 15.5 per cent for 1911. Electrical precipitation of the solid constituents of furnace gases by the Cottrell method is also beginning to attract increased attention. This method has been long and favorably known in connection with smelter fumes, cement dust, etc., and its possibilities with reference to ordinary chimney smoke have been recognized. Practical difficulties lie in the way of its widespread use, but the discussion of these difficulties is in progress and we may look for this method to play an increasing part in the problem of smoke abatement in the future.

The size of boiler units is ever on the increase. Units of 10,000 to 15,000 sq. ft. heating surface are now by no means uncommon. The station of the Detroit Edison Company has four boilers of 23,654 sq. ft. each and recently the Ford plant has installed four six drum single units of 25,000 sq. ft. heating surface each. These are, to date, the largest boiler units installed in the country.

SUPERDREADNAUGHT TURBINES

With prime movers themselves, the most impressive features have been those relating to units of superdreadnaught size.

Thus turbines of 60,000 kw. capacity have reached the status of design and order. These units, for which bids have been submitted to the Interborough Rapid Transit Company, are to consist of three elements of 20,000 kw. each, arranged side by side, the center acting as high pressure and the two side elements in parallel as low-pressure elements. Again the Detroit Edison Company has on order a 45,000 kw. unit comprising a single turbine attached to a single generator while units of equal capacity are on order for the Narragansett Electric Light Company of Providence and for the Commonwealth Edison Company of Chicago. In the second case the unit is cross compound with two generators, while in the third case it is compound with single generator and both elements on the same shaft.

The steam pressure for these huge units are also rising. Thus for the 60,000-kw. unit two conditions were considered, 275 lb. pressure and 270 deg. Fahr. superheat or 600 lb. pressure and enough superheat to give the same temperature, while the Chicago 45,000-kw. unit is reported to be designed for 230 lb. pressure and 200 deg. Fahr. superheat. The size of the condensers for these units has been growing at equal pace. Thus the Chicago unit is to have a surface condenser with 50,000 sq. ft. of surface, and the Narragansett unit a Le Blanc jet condenser and air pump capable of handling 18,000,000 lb. of water per hour.

The test results of the 30,000-kw. units in the Seventy-fourth Street station of the Interborough Rapid Transit Company have naturally attracted the keenest attention. The most economical load was found to be about 26,760 kw. and the water rate at that load 11.25 lb. per kilowatt-hour with a thermal efficiency of 24.81 per cent for the unit. The record for high economy during the year as reported seems to go to a 20,000-kw. unit in Buffalo using steam at 275 lb. pressure and 275 deg. Fahr. superheat, which on test gave a water rate of 10.2 lb.

An interesting long period economy test reported during the year was carried out at the Conners Creek Station of the Detroit Edison Company. Six months records closing November, 1915, showed an average consumption of 1.45 lb. coal per kilowatt-hour. The average calorific value of the coal was 13,606 B.t.u. per pound and the monthly load factor 66 per cent. Four boilers were employed of 23,654 sq. ft. heating surface each, generating steam at 225 lb. pressure and 200 deg. Fahr. superheat.

The dividing line between the turbine and the reciprocating engine is now too clearly drawn to merit discussion or extended notice. In large units and for large plants the turbine stands unrivaled. For small units and in small plants the reciprocating steam engine is still holding its own. In fact the chief rival of the engine for small units is not the turbine but the internal combustion engine of the Diesel or so-called semi-Diesel type. A significant feature in connection with reciprocating steam engines seems to be the general growth in appreciation of the uniflow type, especially where economy with simplicity is of importance.

GAS AND STEAM ENGINE UNITS

An interesting combination of gas and steam engine units is now being worked out at the power plant of the Ford Motor Company. Horizontal gas-steam engines rated at 6000 hp. generate direct current at 250 volts. The ultimate capacity of the plant is to be 54,500 hp. The jacket water of the gas engines is used as feed water for the boilers. The exhaust gases superheat the steam in the receiver between high pressure and low-pressure cylinders and then pass through the jacket of the high-pressure steam cylinder, then through feed water heaters and are then discharged through nozzles into the boiler room stacks where they serve to augment the draft. The results of this combination of steam and internal combustion units will be watched with the keenest interest by power plant engineers.

The Diesel and semi-Diesel types of internal combustion prime movers continue to make progress on the field of small and medium size plants. An interesting series of tests showing results of operation in Texas for eight small stations aggregating 5545 hp. and ranging from units of 170 hp. to 500 hp. gave economic results ranging from 11,492 to 17,154 B.t.u. per kilowatt-hour or thermal efficiencies of 18 per cent to 29.7 per cent on load factors ranging from 35.6 per cent to 64.2 per cent. The sizes of engines of this type are also increasing. Engines of 300 to 600 hp. are very common and a six cylinder unit of 1000 hp. is reported.

Regarding four cycle versus two cycle, the balance of advantage, giving due weight to economy, seems to lie with the former, but the advantages in the way of simplicity which the latter can claim may be counted on to bring some solution to the difficulties which lie in the way of its wider use.

As an illustration of the diversified uses to which the Diesel engine is now being put, the erecting floor of one of the leading builders recently showed units for driving

a direct-current generator, an alternating-current generator, a ventilating fan, an oil pipe line pump and a flour mill through a rope drive. The units ranged in size from 300 to 1000 hp.

Cheap Hydroelectric Power for Chemical Industries

The possibilities of cheap hydroelectric power with reference to the building up of great chemical industries and with special reference to the fixation of nitrogen have been attracting increasing attention and interest. The key to the situation seems to be cheap power, power which can be sold on a high load factor at figures approximating $10 per horsepower year. It will be well to realize what this means as applied to water power development in the United States. In the first place it may be observed that hydroelectric power may be and not infrequently is sold at less than cost—that is, less than cost on any proper basis of accounting. Thus if a consumer will agree to take all of his power between the hours of midnight and 6 o'clock a. m., the power producer may consider that the additional cost of producing this consumer's power between these hours is little or nothing and he may therefore make him a price which is really below cost. In connection with such cases two things should be remembered:

1. Hydroelectric power always means water, and unless there is water in excess, the value of the water used expressed in terms of the average sale value of electricity must be charged against the power developed.

2. The additional cost in terms of labor and supervision for only one consumer may presumably be negligible, but as a mode of accounting the sale of such power at an unduly low rate involves a fallacy. This is readily apparent if extended to the entire output, for example, between midnight and 6 a. m. Whatever is turned out between these hours should share equally in carrying the cost of production, and no one kilowatt or collection of kilowatts should be selected out and sold at less than a proper cost simply because it does not seem to entail additional expense as compared with the balance of the output.

Taking now a price of $10 per horsepower year we have $13.40 as the equivalent per kilowatt year. Money will cost a private corporation, at least on the Pacific Coast, not far from 6 per cent. In order to pay bond interest on the part of an undertaking financed by bond sales and dividends on the part financed by stock sales a return of at least 8 per cent on the investment will be required. Taxes and depreciation will add about 4 per cent more, carrying the fixed charges to say 12 per cent. For a company wholesaling electricity the operating expenses are likely to be in the neighborhood of one quarter the fixed charges, or say 3 per cent. The gross income must be therefore not far from 15 per cent on the investment. Hence with a gross income of $13.40 per kilowatt-year the investment must not exceed $89.33 or say $90 per kilowatt-year sold, up to the point of sale to the consumer.

Now in point of fact there are very few locations where the investment per kilowatt-year sold can be reduced to anything like this figure. Even where peculiarly favorable location might permit a development for some such figure per kilowatt capacity, there is often a long step between the kilowatt sold and the kilowatt capacity.

One of the most favorable, possibly the most favorable of the locations in the United States for such power development on a large scale and at low investment costs is at The Dalles, Oregon, on the Columbia River. Here, for approximately such an investment, some 375,000 kw. may be developed. However, a large part of the investment must be put in, even for the first beginnings of power delivery, and the development cannot be economically justified unless a full load can be assured within a very short period after completion and initial operation of the plant.

Investment Costs Too High

These considerations point the way to some of the more significant problems in connection with the development of very cheap hydroelectric power. Broadly speaking, the investment costs are too high in most developments to permit of sale at the figure required for the fixation of nitrogen and for certain other chemical and metallurgical processes calling for electric power at very low rates. Even in those where the development might be carried out within such limit, full load will be required almost from the start if the business of power production is to rest on a sound economic basis. Time will doubtless bring some adjustment which will permit of the utilization of some of these magnificent power projects, but in the meantime we cannot forget that both capital and labor seek the highest market and that no scheme which attempts to provide power or any other product at less than its fair cost can hope to represent a permanent factor in our economic development.

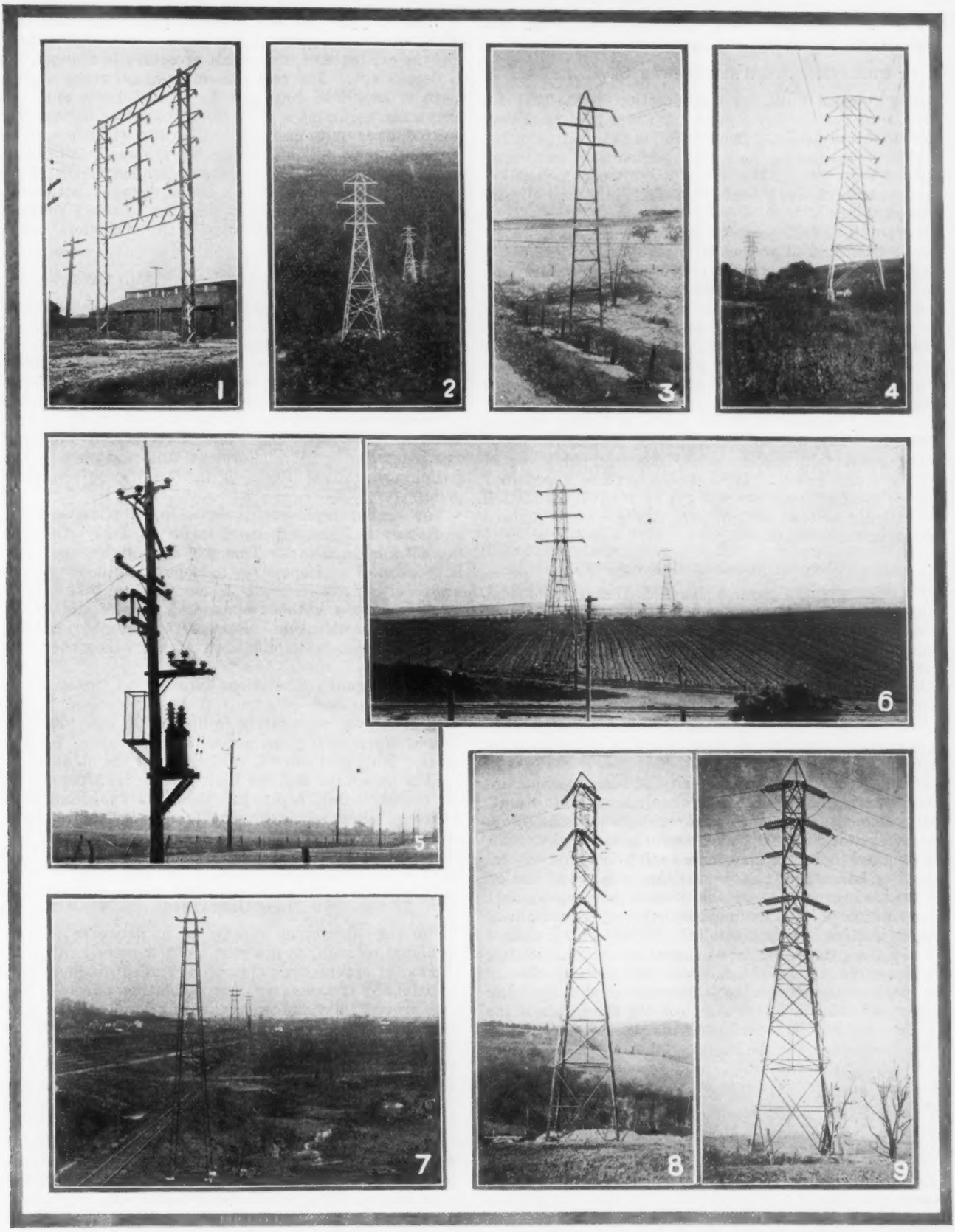
DR. LOUIS BELL

"Attention will be centered more and more upon working out mass operations, a campaign of the organized armies of industrial science."

Water Power Development and the Future of Power Transmission

By Dr. Louis Bell
Consulting Engineer

IT is easy to summarize the progress of power transmission during the last year, but difficult to reckon on what the immediate future will bring. The work of advancement has been mostly in details, individually without sensational features, but collectively of importance in smoothing out the operation of power transmission plants and networks and increasing that reliability of operation which is all-important in the successful distribution of power. If one follows the developments as recorded in the pages of this journal for the last year he will find many items of interest dealing with just these minor but none the less important matters. To characterize the situation briefly, power transmission has spent the last twelve months in consolidat-



1.—Special structure recently constructed from transformer house of Niagara Falls Power Company and carrying six 50,000 circ. mil circuits, replacing wooden pole line.

2.—First steel-tower transmission line in State of Connecticut and fourth that was built in New England. Part of main line of Connecticut Power Line into Hartford.

3.—A frame line of Iowa Railway & Light Company west of Cedar Rapids which operates at 66,000 volts.

4.—1916 line of Duquesne Light Company carrying two three-phase, 66,000-volt, 250,000 circ mil copper cables out of Brunots Island steam station.

5.—Small individual consumer substation on 33,000-volt wood pole line of Dayton (Ohio) Power & Light Company.

6.—A typical transmission line of the Pacific Coast.

7.—Recently constructed 22,000-volt line of Cleveland Electric Illuminating Company, running to Bedford, Ohio, showing 69-ft. structure in foreground.

8 and 9.—Two methods employed to attach cables at strain toers of Windsor (W. Va.) and Canton (Ohio) line of the American Gas & Electric Company from steam plant at Windsor.

Transmission Lines Typical of Present Day Construction

ing the positions just taken rather than in making new and sweeping assaults.

LEGISLATION FOR WATER-POWER DEVELOPMENT

The greatest thing for consideration in the near future is the further development of water powers. Every time that a proposition is made for the utilization of hydraulic privileges in the national domain an immediate howl is raised about the water-power trust, monopolies designed to rob the public of its birthright, and all that sort of thing.

In point of fact there is no such thing as a water-power trust and, if we get sane regulation, there is not likely to be. It is not surprising that investors who have had experience in power transmission should be looking for further opportunities, but the movement is as spontaneous as that which has impelled investors to buy copper or steel or oil stocks in the belief that experience has shown their possession to be profitable. Meanwhile what happens? The hydraulic rights are tied up so that the public cannot use them and many millions of dollars worth of available power runs to waste annually without being put to service in cheapening production and generally meeting public needs for light and power. It is earnestly to be hoped that during the next year we will get reasonable legislation for helping instead of hindering the growth of power transmission systems.

UNION OF TRANSMISSION SYSTEMS

So much for the physical basis of the art, and next comes a question closely allied to it, the union of transmission systems into networks capable of covering the country with a reliable supply of transmitted power. Here again one meets with prejudice which works to public disadvantage. It is perfectly true that now and then there have been unwise mergers of isolated properties with no excuse for being save the desire to trade in securities watered as thoroughly as seemed to be safe.

On the other hand, the majority of increases in common ownership have been with the direct intent of uniting systems to form a coherent whole, which can be operated more efficiently and more economically than before, and therefore may serve both public and owners to better advantage. Every addition of a power station to a growing network means greater security against interruption of service and more efficient utilization of the conducting system installed. With copper around 40 cents a pound this is no mean advantage. Public service corporations in these days expect regulation on the part of the governing authorities and make little objection to this policy of safeguarding the rights of the public provided it is followed openly and fairly and with due regard for the chances taken by the investors in the business. Equitable and reasonable regulation of these properties is one of the things to be hoped for in the near future.

ADVANCE TOWARD HIGHER VOLTAGES

As regards the technical parts of the art the obvious line of advance is toward the more general use and standardization of higher voltages. At the present time the systems of the country represent the successive periods of growth in the development of the art, involving many voltages that should be characterized as intermediate between those of the timid past and those of the conservative present and future. With the advent of suspension insulators the limitations of earlier days have for the most part disappeared, and the question now raised is not what voltage is strictly conservative, but what is required by the conditions of economy.

With copper at its present price the tendency must steadily be upward, and there is no longer reason for the existence of the modest pressures in common use a decade ago. For real transmission networks a pressure of 50,000 to 100,000 volts is reasonable and conservative, assuming a fair amount of power to be transmitted, as is quite universally the case, while in a widespread supply still higher figures are easily attainable when necessary. The inevitable tendency, therefore, will be toward high transmission voltages without a passage through intermediate stages to those voltages from which direct transformation for consumers' use is readily available.

SIMPLIFICATION IN CONSTRUCTION AND OPERATION

Again, there is a great and wholesome tendency toward simplification in construction and operation. The rapidly increasing use of outdoor substations, for example, means lessened cost of supply from widely ramifying lines. And the operation of these substations is gradually becoming more and more thoroughly automatic, so that labor can be utilized chiefly for inspection and controlling rather than for idly watching the operation of transformers and switches. The switching problem itself is in the way of development.

The earlier high-tension switching appliances were, and many still are, expensive to install, bulky and costing not a little in care. That day is going by, and there is promise of appliances for indoor and outdoor use, operated either automatically or manually, to take care of modern voltages without demanding much in the way of inspection or attention. Part of the gain, too, is coming in a greater simplification of the whole operative system.

When a pair of stations are linked together in a common system of supply it is not necessary that each should be elaborately equipped for individual reserves, since each plant serves as the reserve for the other. More and more it is likely to be the habit to regard a generator and its high-tension transformer as the operative unit, and to link these units together with sufficient electro-dynamic cushioning to secure their safe operation. This is the lesson learned from the beautiful flexibility of plants connected through long lines which in themselves safeguard operation.

MASS OPERATION

The time is coming rapidly when networks will be regulated as such, as a whole, and not merely in parts. The use of synchronous apparatus, loaded if convenient, or unloaded if necessary, for regulating purposes has long proved its value and if wisely applied at a few points is capable of giving wonderful steadiness in the performance of systems covering hundreds or even thousands of square miles. The skillful systems of load dispatching already applied in not a few instances are an example of this tendency to look at the big things instead of at the little things. A great deal has been done of late in the perfection of details, of circuit breakers, and lightning arresters, meters and instruments, but all these things should be regarded as means to an end, and that end is the coherent and systematic operation of great distribution systems capable of bringing cheap and reliable power to every consumer within reach, whether on the basis of wholesale or retail service.

In these days the difficulties of simple straightaway transmission are almost negligible, granted sound construction methods and reasonable care. Attention will therefore be centered more and more upon working out mass operations, a campaign of the organized armies of industrial science.

B. A. BEHREND

"As at present, all over the world, conditions are undergoing a radical and complete change, so, in the field of engineering, there is taking place a turn in the tide."

The Signs of the Times in Generating Apparatus

BY B. A. BEHREND
Consulting Engineer

THE tremendous activity of the year 1916 has not been conducive to new developments. Such new developments as take place from time to time require considerable experimental work which cannot be conducted with success in times in which the workshops of the country are filled and crowded to their utmost capacity.

As a result of this state of affairs the most noteworthy work achieved has been along lines which the present writer predicted ten years ago in a paper in *Cassier's Magazine*, in the following words. "We no longer talk without substantial foundation when we consider the building of units of 15,000 hp., or even of 25,000 hp. Such units will be built in the near future, and they will be more substantial and economical than the smaller units. With the growth of the cities the power station of the immediate future will contain as many 20,000 kw. units as the power station of to-day contains units of 5,000 kw." It is with a certain measure of amusement and gratification that the writer recalls the sarcastic remarks made at the time his article appeared. There have since been designed generators and steam turbines even in excess of the sizes stated and these units have been successful in all respects.

LARGE UNITS ESSENTIAL

We may then say, with a considerable measure of truth, that the past year will be remembered as the year in which units of large capacity were realized as essential and important equipment in the power stations of our large cities. The development of these units required certain essential changes in the point of view of the performance of such units. Whereas in the past a great deal of weight was placed on such characteristics as the regulation, the requirements of large units are such that, even if such close regulation were desirable, units could not well be designed without disregard of this particular feature. And it has developed that such disregard has not been at all disadvantageous in the operation of the power stations, so that no difficulties have been experienced on this score.

DIFFICULTIES IN MANUFACTURE

The terrific speeds at which such units as these extremely large units are operated require the use of special grades of alloyed steels, which, in times like the present, are hard to obtain on account of the workshops being filled with pressing commercial work in which quality is a matter of less importance. It is this which causes the designers and the builders of these units a great deal of uneasiness, as it is by no means possible to find substitutes for materials the properties of which have been utilized to the utmost limit.

MATERIAL ALTERATIONS NOT FEASIBLE

It is also not feasible commercially to alter radically and materially the structural designs of machinery because of temporary difficulties experienced in obtaining materials or because of temporary excessive prices which have to be paid for materials under the present extraordinary conditions. While the cost of materials which enter into the construction of electrical machinery has doubled in many cases, yet it must be remembered that the price of labor has also greatly increased and that, in times of great prosperity, the quality and efficiency of the labor of the individual workman are usually inferior to that obtained in normal times. Thus it becomes increasingly necessary to make the designs and the construction as fool-proof as possible so as to be able to utilize with safety even inferior workmanship to which one has to resort in these extraordinary times.

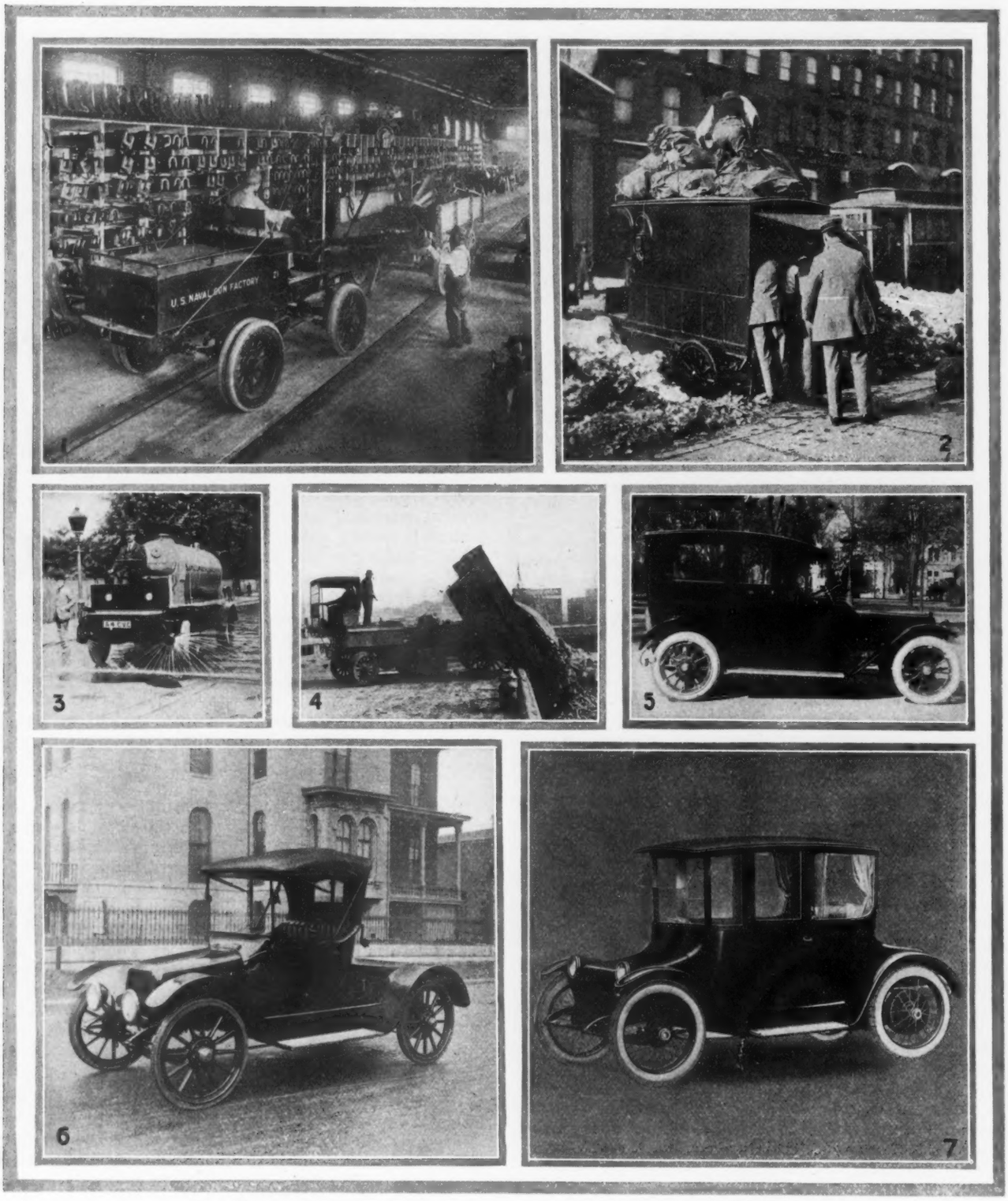
ELECTRIC SHIP PROPULSION

In connection with the adoption of large generating units it is appropriate to refer to the decision reached by the Navy Department of the United States to utilize electric propulsion in the super-dreadnaughts and battle-cruisers which are now being laid down. While in the super-dreadnaughts the speed is moderate and, therefore, the size of the units, generators as well as induction motors, does not exceed conditions with which the designer is familiar, the great speed adopted for battle-cruisers requires units of extraordinary capacity. Here, then, as in the field of stationary engineering, similar tendencies are clearly marked.

CONDITIONS CHANGING RADICALLY

It is, however, in the very nature of things that evolution cannot be perpetually in an upward direction. There must be a time when its course becomes stationary or downward. It is not possible to continue to increase the individual size of a unit beyond a certain limit, and a maximum limit must be reached some time.

It is the writer's opinion that, as at present, all over the world, conditions are undergoing a radical and complete change, so, in the field of engineering, there is taking place a turn in the tide. So far as our own short-sighted vision can picture things, a limited individual size seems to have been reached. It is curious to speculate on the things which lie ahead; in fact, it is a matter of the utmost importance to the engineer to be able to see the future with his mind's eye and to predict the new coming events in his profession. Just so far as he can do this successfully, he is likely to be a pioneer in his own field.



1.—Electric truck equipped with jib crane handling naval guns and pedestal parts in a government gun shop.

2.—Electrics in parcel-post delivery in New York City. Owing to their superior reliability under all weather conditions, these electric wagons are given the longer routes and the heaviest loads. Some are in service twenty-three hours per day, with changes of batteries and drivers.

3.—The electric in municipal service. This American-built electric sprinkling wagon is one of a group purchased by an English city.

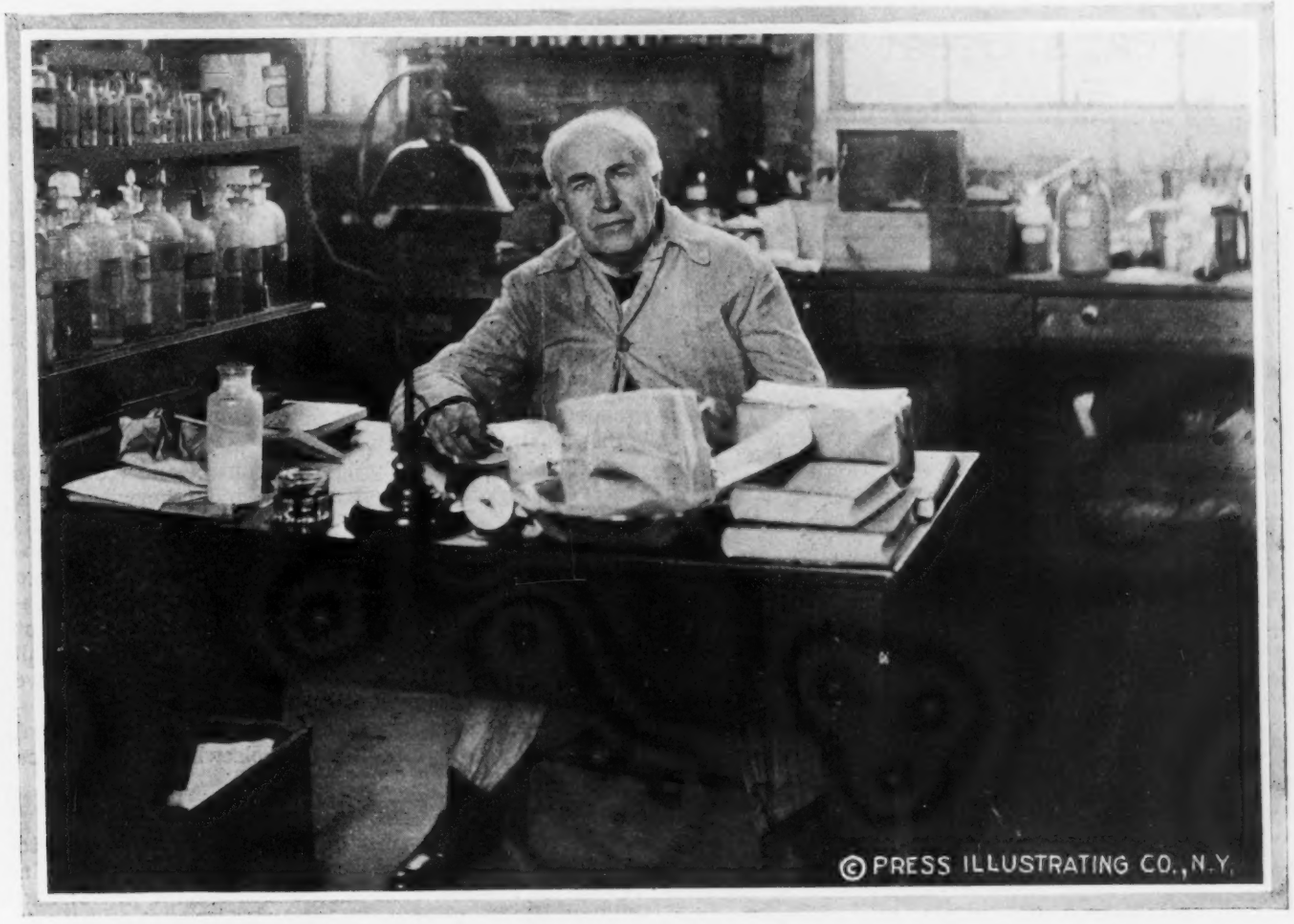
4.—Electric trucks used for hauling garbage and for street-cleaning duty. During the night hours, when not required for this refuse-disposal work, the electric tractor here shown can be quickly and easily "unhitched" and used to haul street-cleaning apparatus.

5.—Electric taxicabs, by reason of their easy-riding and silent-running qualities, cleanliness, and dependability of service, have rapidly won popular favor wherever introduced. Several Eastern cities are now following the lead of Detroit in providing fleets of electric limousines at the call of the public.

6.—The electric in the field of the every-day passenger car. A recent battery-driven runabout designed for the use of central-station men.

7.—One of the latest types of the light electric passenger car. An all-year-round vehicle, especially adapted for the service of the professional or business man and excellent for family use.

The Electric, the Universal Car for Government, Business and Family Use



Seeing Ahead for the Electric Vehicle

An Interview with THOMAS A. EDISON

"THE growth of the electric vehicle has been hindered by lack of charging facilities. Selling electric current is a mercantile business just like any other business. Not enough central stations realize this, and very few search out *every* way that current may be marketed. As a result, undeveloped markets exist for the sale of central station energy. It's a funny business when so few central stations realize that there is a waiting market for the sale of current for charging electric cars. The public is in the curious position of wanting to buy something for which there is no place to go.

"In my opinion the central station should go into the garage business and provide in this way the best means of furnishing a place to which the customer can go to buy what he wants, electric current, in the form of mileage.

"If I were in business to sell current I would find every possible way to sell current. If I were a central station manager I would put up a garage and go into the business of selling electricity for driving cars. I would put up or rent a four or five-story building and install a proper elevator. I would charge vehicles at night on banked fires, just as they do in Hartford, Conn., at the present moment. I would have trucks on the first floor and an elevator big enough to handle pleasure cars on the other floors. I would not sell current for charging but for mileage, which is what the customer wants. I would make a service charge per mile that would include the cost of current. A garage charge of this sort could be made to be profitable to both the central station and the business man. Perhaps I would rent out, under a contract with a reliable firm or person, the washing and repairing of the vehicles at fixed and reasonable prices, relieving me of that detail, and confine myself to the selling of current.

"I believe that the central station should go into the garage business because the electric garage needs the intelligent supervision and reliability that the central station can give it. One of the main difficulties in garaging both gas and electric cars is the lack of knowledge of the average garage man. The storage battery to-day doesn't need experts to supervise it but it does need the same intelligent and responsible care that any mechanical or electrical equipment needs. The average garage standards of this country for either gas or electric cars are far too low. The central station, if it went after the business on the basis of building up a profitable income, would raise the standard of garage service and reap the reward for it. When I say that I have known men in an average garage to pour sulphuric acid into our alkaline batteries, and to make outrageous charges to their customers, it is easy to see that we can never expect the electric to come into its own until we have more intelligence and reliability in the places where cars are charged.

"Even the big men don't seem to realize the opportunity for increasing their sales to the public by establishing charging stations, and by making a profit on selling electric mileage to the community. There is an opportunity for big sales of current on a profitable service basis. Business needs imagination. The electrical business is no exception. Sometimes I think the men who ought to see ten years ahead see only next week."

Year's Great Progress Shown by Statistics

New Records Made in Larger Volume of Business in Every Department of Electrical Activity —Electrical World Figures on Income and Kilowatt-Hour Output

T. C. MARTIN

"The year 1916 has shown that, amidst the wildest prosperity, capital cannot be lured into new railroads or water power conservation under the harsh ban of restrictive and hostile legislation."

Enormous Totals of Gross Business in Every Branch of the Industry

By T. C. Martin

THAT our country has had a year of exceptional prosperity in 1916 is already a commonplace. The figures are stupendous, although we do not begin to realize their ultimate and intrinsic significance. We hate to see the Great War go on, and yet hesitate to entertain peace as a respectable person. We rejoice at gold imports of $600,000,000, glory in exports aiming close to the $4,000,000,000 mark; then wince and foam at the inevitable higher cost of living, and start official investigations to prove that we ourselves are all the criminals who did it on consenting to participate in the profits.

In the extraordinary transition period 1914-1916 there have been vast, incredible changes in output, income, values, losses, by which probably relatively few individuals or concerns have benefited on a spectacular scale, but that there has been a general diffusion of wealth and prosperity is incontestable. From being a "debtor" nation we have reached the point where our loans to foreign nations and cities since the war began has reached $2,000,000,000 and still we are ready to entertain reasonable suggestions for the relief of an over-swollen and bloated gold chest, most of whose contents might as well be under the bed or in the buried crock for all the good they are doing in the war-torn world. It is well to pile up. That is selfish. It is sometimes better to let go, which is both human and divine.

The inter-relation of our energies, activities and industries is in these melancholic days of colossal war-strife closer than ever, but the real conditions cannot possibly be envisaged until the war stops, and any attempt to deal with the presumable data of 1916 is beset with difficulties unequaled by those of the very latest type of golf course. This review deals chiefly, if not wholly, with the development of public utility enterprises in America, and with the manufacturing production mostly a corollary thereof; but we are confronted with weird and startling facts both among our fellow member companies in the kindred industry in other parts of the Americas and in Europe, as to the imposition of the heavy hand of control and restriction for reasons of "national safety" and otherwise. We, perhaps, begin to realize that in the next kingdoms to come of the earth there may be worse terrors than public service commissions and that a mere coal embargo and confiscation may be a blessing in disguise, as compared with drawbacks and disturbances such as confront electrical industries elsewhere in the world. In all respects there may already, though it is doubtful, have ceased to be any question as to the possibility and desirability of the coming of the price of peace. The real question for us, here no less than elsewhere, is the price of peace.

Electricity in Front

All of which is, by way of incidental and collateral to an estimation of where we electricals stand in 1916 in respect to the activities of the nation as a whole; and of the relation to other industries. That electricity is far up, a front liner, is not in doubt, which means it is also within scale. The statement has been made that 70 per cent of the people in the United States use electricity in some service or other in their daily lives, and that means 75,000,000 at least, on the latest figures of population. This is probably as high a ratio as that of the steam railroads, if not higher. There are many remote districts that the railroad will never penetrate, but where the telephone line and the power transmission circuit have been familiar for years; and the end of such far-flung electrical service is not yet. Out of such universality of service, large totals must inevitably ensue.

It is to be noted that the railroads, with 230,500 miles, carried from operation in 1916 not less than $15,655 per mile, or gross receipts in excess of $3,600,000,000, with a net of $1,098,000,000. This is the highest record, and might serve to indicate that generally the railroads are in prosperous circumstances; but on the other hand there is the significant little fact that little new railroad mileage was built in 1916—only 1098 miles, or the smallest except that of 1915 since the Civil War. There is a suggestive parallel here as to later lack of expansion, from causes not unlike, with the present paralysis of American water-power development. The year 1916 has shown that amid the wildest prosperity, capital cannot be lured into new railroads or water-power conservation under the harsh ban of restrictive and hostile legislation.

The electrical utilities and industries as a group are fast overtaking the railroads as a group in total investment and earnings. If the utilities or "service companies" be taken alone they show for 1916 a total income of not less than $1,750,000,000; and if we add electrical manufacturing and the various other branches of supply and service outside of straight utilities we reach a grand total that must be somewhere around

$2,500,000,000. This is certainly an impressive figure, especially when taken in relation with the high electrical rates of increase. The agricultural produce of the country is valued for 1916 at not quite $6,800,000,000, which puts it easily next to railroads. Textiles in 1914 were valued at $3,414,615,000 and iron and steel and their products at $3,223,144,000. It would appear, allowing as must be done, for abnormal increases in both in 1915 and 1916, that electricity must even now stand not lower than fifth among the producers and contributors to our national wealth. If export trade is to be regarded as a specific department, with its $3,547,000,000 in 1915 and about $5,400,000,000 in 1916, this would leave electricity in sixth place. As to utilities considered alone, they are in second place, after railroads. As to manufacturing alone, it is one of the great group of twenty-five leading industries of the country, according to value of product.

TELEGRAPH EXPANSION

Narrowing down to closer details, we may best take the leading electrical departments in brief review, for reaching our gross figures of 1916. "E. and O. E." Taking first the good old field of telegraphy, we find there conditions of prosperity and activity, due to the enterprise of private capital, as thus acknowledged in a November editorial in the Government organ of the kindred service in England, which says: "We can look with a little envy upon the greater elasticity with which the American administrations can adapt their telegraph methods to industrial needs by means of particularly rapid services. We should be more than human if we did not view with envy the position of an administration which in ten years' time has come not very far short of trebling the traffic." Not only is there life in the old dog yet, but she has bred a fine lot of pups. Western Union receipts in 1910 of $33,889,202 ran up to more than $51,000,000 in 1915, a magnificent showing to say the least, rivaling the younger, larger fields in rate of increase. When one adds for 1916 the totals of the great Postal Telegraph systems, the earnings of all the cables, the wireless business, fire alarm, police alarm, burglar alarm and other numerous services, a total of $150,000,000 does not seem out of the way.

PROGRESS IN TELEPHONY

Next in line may be taken telephony. Here again is found no want of increase and progressiveness. During the past ten years the gross revenue of the Bell Telephone system has increased about 110 per cent, from $128,500,000 to $270,000,000. This is a measure of the growth of telephony as a whole, but leaves indefinite a great many items, more particularly the income of the independent systems, sometimes reported individually, but nowhere to be found as a whole, except when the five-year canvass of the United States Census Office is made. The figure of $400,000,000 may be set down as it was last year, which does not imply any stagnation, for the conditions are all the other way, but the margin of uncertainty is lessened. Great feats, especially in wireless, are on the telephonic roll of fame for 1916, but they may perhaps better be read in terms of publicity than of income. It is all to the good!

ELECTRIC RAILWAY

The electric railway meant at one time only the street trolley, but now includes the elevated and the subway, with many suburban and interurban lines, main line terminals, and big stretches of track away out in the distance. The best of income for all the trolley systems of every kind is the United States census figure of 1912, which gave for that year a total just up to $586,000,000. The conservative estimate of the writer of the whole electric traction field for 1915 was only $700,000,000, or at the rate of about 5 per cent increase annually. This seems low, but the data collected by the American Electric Railway Association for 1915-1916 over about 30 per cent of the mileage showed an increase in operating revenues of 3.47 per cent. Hence the $700,000,000 figure could not have been much out of the way for electric traction as a whole, and meanwhile the conditions have been greatly improving, and the field has shown most marked signs of revival and expansions. Strikes and jitneys have been lived down, and the growth of population goes on as ever, offsetting substantially any slight reduction in revenue per passenger; while in many instances fares have gone up. The income of electric traction service as a whole in 1916 can be safely put at $750,000,000.

CENTRAL STATION GROWTH

Estimates of income in the central station field are on a very firm basis, due to the excellent work of the ELECTRICAL WORLD in its monthly compilations drawn from authentic reports covering at least 60 per cent of the industry. These statistics have now been thoroughly tried out and compare very favorably with those in any other national field of activity. They check up closely with those obtainable in other ways, as for example, the percentage dues on income of the member companies of the National Electric Light Association, and enjoy the element of dependability, having been tested through a two-year period of violent vicissitudes in central station affairs. The records show beyond any doubt that the total station income for 1916 is far in excess of that of any previous year, taken month by month and in the aggregate. From earnings alone a total of $425,000,000 has certainly been reached; it may well be $450,000,000. Besides which about 2000 central stations are in the supply business, and many are in the steam heating, ice-making, and other collateral lines. It may not be a poor guess to put down $500,000,000 for the central stations in 1916.

ISOLATED PLANT DEVELOPMENT

As collateral to this, it may be noted that last year, the writer assumed the value of isolated plant service at $125,000,000, and thought the figure to be high. Last September the ELECTRICAL WORLD came along and put the same estimate up to $201,600,000, after a very careful survey of the field. Something is wrong somewhere when estimates are thus widely apart, but perhaps it may all be explained by the enormous overtime working of such plants in war years, and this would fit in with many other data of a munition era. If $150,000,000 is set down for 1916 it may be taken as exuberantly conservative on the part of one who is desirous of making out the best kind of brief for electricity.

MANUFACTURING PROGRESS

The intricacies of any calculation as to the value of electrical manufacturing output are beyond description, but everybody knows them, none better than the manufacturer in buying raw material or in gaging the prospective market in equivocal days when the howling times of war may at any moment become the piping times of peace.

The total value of electrical manufacturing output in 1914 of 1121 establishments was $359,412,676, and that was by no means all, for it did not include a variety of things, such as porcelain electrical supplies, globes, battery jars for electrical use, a mass of poles, pins, crossarms, telephone cabinets, etc. On the straight, distinctive stuff, the increase of output from 1909 to 1914 was 50 per cent, or 10 per cent a year,

so that the figure given in these pages last January of $450,000,000 was well within the mark. But what are we going to say now, when prices of raw materials have climbed to the skies, and when there has been shortage of every kind of appliance and apparatus in spite of it and because of it? Copper as compared with two years ago shows an approximate increase of 220 per cent, and steel 300, alloys 200 to 800, rubber 110 to 125; cotton 130 to 150, lead and spelter 200—and so on all up and down the line, not forgetting note paper, due perhaps to the inordinate use of it made in communications to European governments. But summing it all up and allowing that the gross figure of $450,000,000 for electrical manufacturing was warranted for 1915, it would seem that at least a 20 per cent increase is justifiable for 1916, or say roughly, $550,000,000. This has nothing to do with munitions. The output might be and could have been even greater but for the war and should not let up whenever in God's mercy it ends.

DEVELOPMENT IN MISCELLANEOUS FIELDS

There is an endless amount of electric service not included in any of the above categories, of which merely electro-therapy and electric vehicle service may be mentioned as one item. To sum it up is impossible, but as heretofore a total of $125,000,000 is attached to it. Quite likely it may be less, or easily it might be more. Thus coming out at the end of the inquiry as to what electricity in service and supplies represents to the American public in 1916, we reach the total as shown in the following table:

	1916.
Telegraphy of all kinds	$150,000,000
Telephony	400,000,000
Central Stations (earnings from all sources)	500,000,000
Electric Railways	750,000,000
Isolated Plants	150,000,000
Electrical Manufacturing	550,000,000
Miscellaneous	125,000,000
	$2,625,000,000

This may seem a formidable total, but is quite probably under the mark. It is only $235,000,000 above the figure estimated for 1915 in spite of service to the public at a constantly lowering cost.

INCOME FROM ENERGY SALE $417,000,000 IN 1916

Kilowatt-Hour Output Estimated at 23,300,000,000, an Increase of 4,400,000,000 Kw.-Hr. Over 1916—October Output Passes Two Billion Mark

CENTRAL station earnings and output during 1916, according to returns made to the ELECTRICAL WORLD, reflected the big business condition that prevailed during the past twelve months. Based on these returns with estimates for the months of November and December, for which no figures have yet been received, the earnings from the sale of energy in 1916 were $417,000,000. This is larger than the 1915 earnings by more than 15 per cent, or roughly $55,000,000. The output for 1916 amounted to 23,300,000,000 kw.-hr., an increase of 4,400,000,000 kw.-hr. over 1915, or 23 per cent. The earnings are from the sale of electrical energy only and do not include any of the other miscellaneous central station earnings, such as merchandising sales or profits, interest on bonds held in the treasury or service connection charges.

TABLE I—CENTRAL-STATION RETURNS FOR TWELVE-MONTH PERIOD

	Percentage of Industry Represented	Income from the Sale of Energy			Kw.-Hr. Output		
		1915	1914	Per Cent Increase	1915	1914	Per Cent Increase
Nov.	65	21,899,048	19,720,232	11.6	1,150,669,073	948,704,941	21.3
Dec.	64	23,418,774	20,962,264	11.8	1,230,655,404	1,004,108,399	22.5
		1916	1915		1916	1915	
Jan.	65	25,286,336	22,352,721	13.2	1,200,672,452	984,205,683	22.0
Feb.	65	22,133,485	19,175,537	15.3	1,121,452,738	869,537,132	29.1
March	65	22,027,627	18,722,742	17.8	1,212,363,217	969,888,339	25.2
April	64	21,206,946	18,375,014	15.5	1,137,602,995	920,464,917	23.1
May	64	20,345,529	17,559,786	16.0	1,170,143,766	944,681,881	24.0
June	64	20,254,732	17,551,769	15.4	1,170,679,212	968,724,416	21.0
July	64	19,760,120	17,301,686	14.2	1,174,374,141	976,704,993	24.4
Aug.	64	20,502,137	17,861,413	15.0	1,262,575,492	1,015,805,383	22.4
Sept.	64	21,432,670	18,600,229	15.2	1,268,339,571	1,037,976,528	21.2
Oct.	57	20,510,753	17,899,429	14.7	1,190,435,370	985,920,332	21.8

TABLE II—CENTRAL-STATION RETURNS BY SECTIONS OVER A TWELVE MONTH PERIOD

	Month	New England States				Atlantic States				Central States (Illinois Excluded)				Pacific and Mountain States		
		Percentage of Industry Represented	1915	1914	Per Cent Increase	Percentage of Industry Represented	1915	1914	Per Cent Increase	Percentage of Industry Represented	1915	1914	Per Cent Increase	Percentage of Industry Represented	1915	1914	Per Cent Increase
INCOME	November	66	2,472,539	2,188,049	13.0	67	8,894,805	8,158,589	9.0	57	6,342,582	5,554,226	14.2	88	4,069,995	3,703,124	10.0
	December	66	2,817,557	2,448,813	15.0	67	9,335,396	8,529,866	9.4	57	6,983,909	6,063,349	15.1	88	4,150,045	3,773,810	10.0
			1916	1915			1916	1915			1916	1915			1916	1915	
	January	66	2,819,144	2,432,177	15.0	67	9,589,347	8,564,488	12.0	57	7,834,831	6,717,799	16.6	88	4,182,114	3,823,156	9.4
	February	66	2,599,760	2,185,967	18.8	67	8,978,797	7,854,345	14.3	57	6,660,062	5,568,337	19.7	88	3,761,364	3,443,182	9.3
	March	66	2,595,777	2,122,177	22.0	67	8,998,962	7,660,667	17.5	57	6,470,612	5,394,250	20.1	88	3,787,925	3,386,286	11.9
	April	64	2,221,544	1,898,749	17.0	67	8,794,056	7,596,567	15.8	56	6,289,092	5,292,974	19.0	88	3,825,701	3,520,381	8.8
	May	65	2,103,585	1,788,219	17.0	67	8,226,231	7,131,063	15.4	56	6,085,407	5,123,132	18.7	88	3,874,270	3,469,871	11.6
	June	65	2,208,994	1,906,233	16.0	67	8,045,839	6,905,114	16.5	56	6,007,742	5,143,452	16.9	88	4,017,208	3,539,137	13.5
	July	65	2,130,684	1,875,824	13.7	67	7,832,928	6,621,832	16.4	56	5,926,776	5,095,855	16.3	88	3,755,712	3,493,032	7.6
	August	65	2,203,795	1,935,828	13.7	66	8,000,243	6,875,625	16.4	56	6,195,808	5,266,147	17.7	88	3,883,835	3,582,756	8.4
	Sept.	65	2,315,514	1,982,050	16.8	66	8,631,725	7,445,243	16.0	56	6,505,593	5,537,868	17.8	88	3,979,838	3,644,058	9.2
	October	64	2,624,591	22,795,512	15.1	57	7,760,435	6,882,721	12.8	52	6,810,006	5,790,232	17.5	74	3,185,687	2,829 848	12.5
KW.-HR. OUTPUT	November	66	87,193,883	69,359,620	25.8	67	420,584,253	355,151,259	18.5	57	333,528,905	269,870,536	23.7	88	301,772,412	248,913,893	21.0
	December	66	99,744,195	80,446,521	24.1	67	447,158,465	373,213,316	20.0	57	363,859,444	293,266,707	24.1	88	311,034,100	249,996,678	24.5
			1916	1915			1916	1915			1916	1915			1916	1915	
	January	66	97,072,794	77,029,974	26.2	67	431,201,554	356,809,437	20.8	57	362,121,067	284,407,361	27.5	88	301,645,060	258,982,414	16.5
	February	66	92,855,679	68,982,535	34.8	67	411,715,612	320,924,478	28.1	57	339,326,360	252,816,291	34.1	88	268,653,564	220,662,826	22.1
	March	66	97,321,924	74,958,898	29.9	67	439,660,902	349,347,454	26.0	57	360,872,072	282,179,673	28.0	88	304,327,753	255,450,143	19.3
	April	64	84,769,660	64,816,830	30.8	67	403,223,021	326,574,302	23.4	56	344,866,175	273,367,413	26.4	88	302,386,347	253,778,348	19.2
	May	65	84,719,642	64,318,892	31.8	67	409,529,049	333,585,886	22.0	56	345,860,257	275,328,229	25.6	88	328,793,909	266,599,708	23.2
	June	65	87,829,797	69,506,884	27.6	67	396,630,887	327,541,507	21.2	56	350,015,166	288,982,024	21.2	88	328,996,553	277,915,476	18.6
	July	65	85,317,206	71,160,365	19.8	67	401,179,678	333,771,509	20.3	56	350,708,540	287,407,170	22.2	88	325,647,543	279,285,871	17.4
	August	65	97,197,131	72,900,805	33.4	66	433,129,067	344,730,909	25.7	56	374,327,105	295,866,692	26.5	88	333,468,777	279,976,391	19.1
	Sept.	65	98,350,508	73,343,561	34.2	66	446,534,743	369,815,165	20.8	56	387,626,725	307,485,471	26.2	88	335,817,595	288,332,331	16.4
	Oct.	64	105,641,881	81,832,381	29.3	57	407,950,506	358,105,577	14.0	52	390,293,287	312,571,363	25.0	74	277,744,432	226,336,000	22.7

TABLE III—CENTRAL STATION RETURNS SHOWING NUMBER OF CUSTOMERS, CONNECTED LOAD AND GENERATING CAPACITY FOR THE YEARS 1916 AND 1915

Territory	Total Customers		Total Connected Load in Kw.		Total Generating Capacity in Kw.	
	1916	1915	1916	1915	1916	1915
United States (37 per cent)	2,060,951	1,856,716	5,242,231	4,623,618	3,044,610	2,773,422
New England (53 per cent)	302,030	260,921	684,245	576,373	406,809	357,695
Atlantic (43 per cent)	519,046	455,183	1,628,987	1,384,976	1,021,546	901,635
Central (30 per cent)	606,324	550,770	1,626,598	1,510,287	743,771	689,623
Pacific Mountain (35 per cent)	633,557	589,842	1,302,401	1,151,982	872,384	824,469

TABLE IV—PERCENTAGE RATE OF INCREASE IN INCOME AND KILOWATT-HOUR OUTPUT FOR UNITED STATES—CITIES GROUPED BY SIZE

	Jan.	Feb	Mch.	April	May	June	July	Aug.	Sept.	Oct.
INCOME:										
Group 1	10.7	14.1	16.0	13.9	14.4	14.9	13.8	13.9	15.0	13.0
Group 2	21.3	20.0	18.5	17.0	17.5	17.7	16.8	15.7	20.4	18.5
Group 3	18.3	20.7	28.1	24.7	26.2	21.8	19.5	20.9	18.4	19.7
Group 4	13.1	15.7	17.3	17.4	15.1	11.0	9.0	9.5	11.3	14.8
Group 5	7.2	18.5	26.5	16.1	24.0	15.3	12.2	14.9	13.3	17.2
OUTPUT:										
Group 1	19.0	25.4	22.0	20.0	21.3	18.7	18.1	21.4	18.5	17.5
Group 2	28.0	40.6	28.1	25.5	18.0	17.5	22.9	33.0	32.9	30.8
Group 3	33.2	39.6	39.0	37.7	40.0	21.8	27.8	31.1	19.3	24.3
Group 4	22.6	29.7	18.2	22.7	23.0	19.3	16.1	23.0	26.0	22.0
Group 5	8.5	22.4	29.9	32.0	33.2	19.0	11.6	16.8	15.3	19.3

October returns gave a total of $36,000,000 from energy sales, an increase of 14.7 per cent. For the first time in the history of the lighting industry the output passed the 2,000,000,000 mark. The October output was 2,090,000,000 kw.-hr., an increase over October, 1915, of 21.8 per cent.

With the exception of the Pacific and Mountain States all sections of the country showed smaller percentage increases in earnings and output in October

TABLE V—PERCENTAGE RATE OF INCREASE IN INCOME AND KILOWATT-HOUR OUTPUT FOR NEW ENGLAND STATES—CITIES GROUPED ACCORDING TO SIZE

	Jan.	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct.
INCOME:										
Group 1	16.5	18.0	21.5	16.0	17.0	16.4	12.6	9.6	16.5	12.2
Group 2	15.4	19.9	19.0	21.2	19.5	19.8	20.6	15.1	25.5	21.6
Group 3	22.1	29.7	38.7	15.5	24.0	18.2	21.2	15.0	20.5	18.0
Group 4	11.3	15.1	18.1	13.2	13.5	7.2	6.2	11.1	10.5	15.4
Group 5	20.6	26.3	54.5	27.6	27.0	21.7	14.9	17.5	18.3	18.2
OUTPUT:										
Group 1	29.0	38.5	30.9	25.0	28.2	30.9	19.2	31.3	34.0	17.6
Group 2	26.0	36.8	27.8	31.4	33.2	26.3	14.1	32.0	37.7	36.5
Group 3	39.5	41.6	49.0	38.1	43.0	15.0	31.4	45.5	32.4	42.6
Group 4	15.0	23.0	17.4	36.1	30.0	21.0	26.6	39.4	32.9	48.9
Group 5	22.6	25.6	58.7	71.8	54.4	31.7	13.5	21.3	27.4	22.0

last over October, 1915, in comparison with that registered in the preceding month. This, however, in no way reflects poorly on October, 1916, because October, 1915, was a splendid month in comparison with the months that went before it. In the Far Western States the same condition probably holds. The returns from one of the largest companies in the section are missing, but based on returns from previous months it is quite probable that the complete figures from this section

TABLE VI—PERCENTAGE RATE OF INCREASE IN INCOME AND KILOWATT-HOUR OUTPUT FOR ATLANTIC STATES—CITIES GROUPED BY SIZE

	Jan.	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct.
INCOME:										
Group 1	11.1	13.7	16.7	15.1	14.5	16.4	16.8	16.1	16.2	12.9
Group 2	18.2	18.4	21.2	81.5	21.7	21.9	18.5	21.6	19.0	17.6
Group 3	11.9	14.6	20.5	15.3	17.7	12.0	14.2	15.0	14.0	14.5
Group 4	17.4	19.4	17.9	19.5	14.0	15.4	10.0	14.4	9.8	13.6
Group 5	16.0	15.8	12.2	15.6	13.0	15.2	13.0	19.4	8.9	14.3
OUTPUT:										
Group 1	21.1	30.8	29.2	26.1	25.5	13.1	23.4	28.5	23.6	17.0
Group 2	26.4	33.4	25.6	35.6	11.3	31.8	27.4	32.5	26.7	30.5
Group 3	20.1	22.0	16.0	13.7	18.0	13.2	11.5	16.0	24.7	4.3
Group 4	15.6	21.8	20.9	19.0	12.6	19.7	16.3	29.5	18.6	18.0
Group 5	1.5	24.0	13.1	8.9	35.0	11.1	13.5	20.4	1.3	1.5

TABLE VII—PERCENTAGE RATE OF INCREASE IN INCOME AND KILOWATT-HOUR OUTPUT FOR CENTRAL STATES—CITIES GROUPED BY SIZE

	Jan.	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct.
INCOME:										
Group 1	14.3	18.3	19.3	18.2	18.0	16.4	15.8	16.5	16.6	17.3
Group 2	25.5	20.5	19.1	18.0	17.4	17.5	17.3	21.8	21.5	20.1
Group 3	24.3	27.0	23.0	26.7	27.2	20.5	18.6	18.4	13.4	10.9
Group 4	9.6	20.2	22.9	22.8	24.1	17.5	17.5	10.7	20.0	19.7
Group 5	5.7	11.1	14.4	9.4	21.3	12.6	6.1	11.8	11.0	18.4
OUTPUT:										
Group 1	24.9	30.3	25.2	24.7	25.0	23.8	21.0	24.3	22.3	23.3
Group 2	28.8	44.0	32.3	23.9	19.5	12.3	25.7	36.4	40.0	31.7
Group 3	32.5	44.0	40.6	43.5	41.0	31.8	26.0	25.7	20.7	17.3
Group 4	53.4	41.0	31.9	39.2	38.5	34.3	21.1	23.0	33.8	27.0
Group 5	13.3	15.9	19.1	10.1	14.7	4.0	8.6	6.1	13.7	28.2

will show smaller percentages of increase over October, 1915.

Additional figures were reported by about half of the reporting companies of customers, connected load and generating capacity. Companies representing 37 per cent of the generating capacity of the United States reported 2,060,951 customers at the end of 1916 against 1,856,716 at the end of 1915, a gain during the year of more than 200,000, or 11.1 per cent. These figures include but a few of the companies operating in the very large cities and for that reason should not be multiplied by three to arrive at an estimated total for the country.

Figures representing connected load and capacity are shown graphically in Fig. 7, on page 34, for the entire country, estimated from the partial returns received by the ELECTRICAL WORLD.

For connected load from 37 per cent of the country the figures are 5,242,231 kw. in 1916 and 4,623,618 kw. in 1915, a gain of 13.5 per cent. Generator capacity figures for 37 per cent of the United States are 3,044,610 kw. in 1916 and 2,773,422 in 1915, a gain of 10 per cent. The figures are grouped sectionally in an accompanying table.

FIGURES REAL BAROMETER OF INDUSTRIAL CONDITIONS

Central station figures are undoubtedly a real barometer of industrial and business conditions. In 1915, while the earnings never went below those for the previous year, the per cent increases fell off during the first six months, after which they responded to the call of Europe for munitions, and from then until the

TABLE VIII—PERCENTAGE RATE OF INCREASE IN INCOME AND KILOWATT HOUR OUTPUT FOR PACIFIC AND MOUNTAIN STATES—CITIES GROUPED ACCORDING TO SIZE

	Jan.	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct.
INCOME:										
Group 1	11.6	6.7	8.5	3.9	7.2	7.5	4.7	5.5	6.2	8.3
Group 2	†	†	18.7	3.5*	2.3	1.2	0.6*	0.7	4.9	1.3
Group 3	19.7	22.0	28.1	40.0	39.0	39.5	28.3	32.5	28.5	32.4
Group 4	3.0	8.2	17.5	11.7	13.8	3.6	1.0	0.5	11.5	9.8
Group 5	10.5	17.8	26.3	12.0	19.1	12.8	13.2	13.0	11.7	14.4
OUTPUT:										
Group 1	9.1	13.9	22.7	8.0	12.0	8.0	10.0	6.3	7.1	10.3
Group 2	†	†	28.3	3.6*	2.2	1.9	2.0	6.5	7.8	9.7
Group 3	56.0	68.8	39.0	80.0	79.0	74.5	56.1	57.5	60.0	63.7
Group 4	1.8	13.8	18.6	10.3	21.8	10.0	4.0	7.5	12.0	1.7*
Group 5	1.0	20.1	30.0	11.7	17.5	16.0	10.8	16.5	7.0	9.8

*Decrease. †Results omitted owing to insufficient returns.

beginning of the past year the rate of growth increased rapidly. In 1916, when the industries were even working at maximum output, any gain would naturally have to be at a regular and practically constant rate. The average rate of increase in earnings, it will be noticed, was 15.4 per cent, from which the maximum deviations were small. The low was 13.2 per cent, the high 17.8 per cent. The average rate of increase in output was

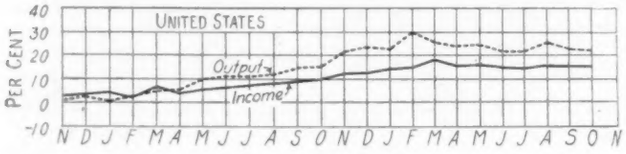
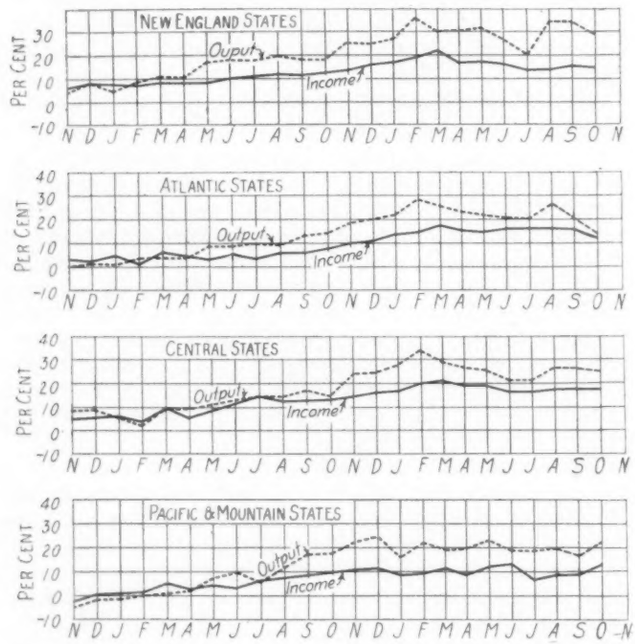


FIG. 1—CENTRAL STATION INCOME AND OUTPUT GAIN BY MONTHS IN PER CENT FOR UNITED STATES

23 per cent, from which the maximum deviations were also small. The low was 20.4 per cent and the high 29.1 per cent.

The year 1916 was one of large demand for power. The volume of orders for motors overtaxed the manufacturing facilities set apart for this product. The increase in domestic lighting load was not as great as was anticipated. This was undoubtedly due to high construction costs, lessening the amount of new building, and to the high price of copper, cutting down on the wiring of houses already built. The sale of electric household appliances, however, was larger in 1916 than ever before because, it is believed, of higher wages in 1916.

The year opened with the center of activity on war orders, but as the year moved on it was noticed that practically all industries were about equally affected. Mining was never before carried on on such a stupendous scale; clothing and machine factories were working at capacity output, iron and steel mills weekly got further behind in production. In practically every branch of industry electrical energy was used, and as a result of the tremendous growth in output and the rapid approach of the load towards station capacity the


NEW ENGLAND STATES
ATLANTIC STATES
CENTRAL STATES
PACIFIC & MOUNTAIN STATES
PER CENT
Output
Income
N D J F MA M J J A S O N D J F MA M J J A S O N

FIGS. 2 TO 5—CENTRAL STATION INCOME AND OUTPUT GAIN BY MONTHS IN PER CENT SECTIONALLY

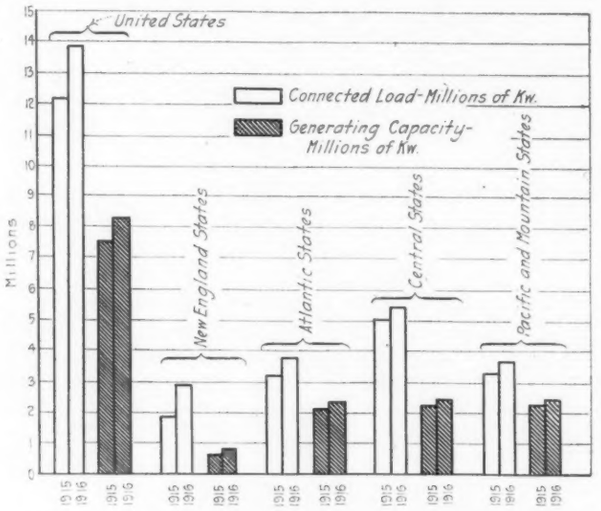


FIG. 7—CONNECTED LOAD AND GENERATING CAPACITY SECTIONALLY FOR 1915 AND 1916

central stations placed in 1916 orders for close to 2,000,000 kw. in steam turbines and in the neighborhood of 400,000 kw. in water turbines.

Figs. 1-5 show graphically the percentages of increase in income and output as contained in Tables I and II. Fig. 6 shows the monthly income and output during 1915 and 1916 of the entire central station industry of the United States. Fig. 7 shows graphically the connected load and station generating capacity of the entire industry for 1915 and 1916 based on partial returns given in Table III. The remaining tables show the percentages of increase in income and output for companies grouped according to the size of the community served. Group 1 contains those companies operating in cities having a population of over 100,000 inhabitants; group 2 in towns between 50,000 and 100,000; group 3, between 25,000 and 50,000; group 4, between 10,000 and 25,000, and group 5, between 5000 and 10,000.

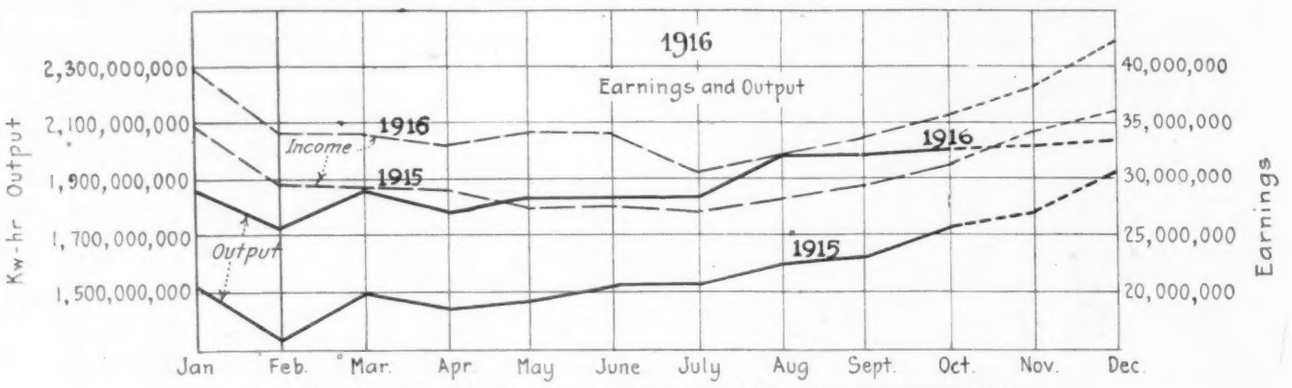


FIG 6—MONTHLY INCOME AND OUTPUT FOR 1916 COMPARED WITH 1915

SLIDE GUIDE & GRIPPER

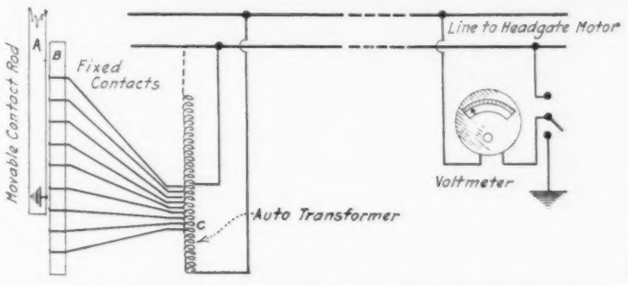
STATION AND OPERATING PRACTICE

A Department Devoted to Problems of Installation, Operation and Maintenance of Equipment for Economical Generation and Distribution of Electrical Energy

Method of Indicating Head Gate Position by a Voltmeter

BY WILLIAM J. HAZARD
Professor Electrical Engineering, Colorado School of Mines

A description of ingenious signaling devices appeared in the ELECTRICAL WORLD of Nov. 18, 1916, on page 1007. One of these shows the amount of motion of a headgate, by flash lamp signals. The position of the gate is then found from the previous position and the distance moved. In this connection the accompanying scheme devised at the Colorado School of Mines, whereby an alternating-current voltmeter is used as a position indicator, may be of interest. It shows the exact position or amount of opening of a gate at all times, without any calculation or record of previous position.



AN ARRANGEMENT TO SHOW POSITIONS OF HEAD GATES

The rod of wood *A* carries a grounded contact piece. This rod moves with the gate or at a proportional rate. An autotransformer *C* is connected to the line supplying the driving motor and as many taps as needed are brought out to stationary contacts as shown. One side of the voltmeter is connected to the line where it passes through the control station and the other side is grounded to save stringing a special signal wire. When the rod *A* is at the lowest point of its travel, it grounds one point of the autotransformer and applies a minimum pressure to the voltmeter. As *A* rises, it makes contact with successively higher voltage taps. The voltmeter scale has divisions added to it, showing the position of the gate on each step.

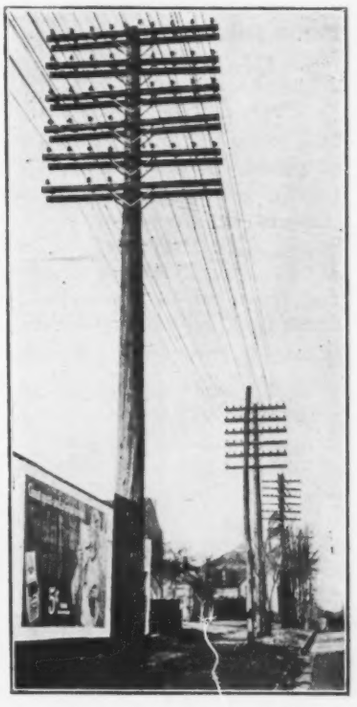
As the first 15 per cent to 25 per cent of the range of an alternating-current voltmeter is no good, it is well to make the voltage for closed gate, high enough to be accurately read. Where the voltmeter range covers the line potential, it may be connected as shown in the diagram. Where a 125 or 150-volt instrument is to be used on a 220 or 440-volt line, it is only necessary to wind the autotransformer for line voltage and use as much of it as needed for the voltmeter.

As shown here the indications are intermittent. Of course the contact on rod *A* must not touch two stationary contacts at once or a section of the transformer winding would be short-circuited. To produce a continuous indication, it is only necessary to put two contacts close together on rod *A* and connect them through a resistance. These contacts must be proportioned so that neither one will close the circuit between the two stationary contacts, but so that one or both will make connection with a stationary contact at all times. The resistance connecting the two points on *A* may be high enough to prevent an injurious current through any section of the transformer and still be low enough to make no appreciable difference in the voltmeter reading. If the middle point of this resistance be grounded instead of one end, it will double the number of steps obtained on the voltmeter by showing voltages half way between taps.

A number of modifications of this scheme, to adapt it to local conditions will suggest themselves to one having use for such an indicator.

A Wood Pole Line That Carries 12,700 Lb. per 1000 Ft. in Conductors

The pole line shown in the accompanying illustration was recently erected by the Evansville (Ind.) Public Service Company to replace an old lead which had been in service for a period of about fifteen years. The old lead of ordinary construction, was partially destroyed in a storm so that for the new line the company decided on a construction of greater strength. Northern white cedar poles were selected and specified 45 ft. tall with nothing less than 11-in. tops. Considerable difficulty was experienced in securing poles of this size, however with the co-operation of the Naugle Pole & Tie Company in searching its yards sixty 45-ft. poles and twenty-five 55-ft. poles with 8-in. tops were finally located. Each pole butt was treated at the pole yards by immersion in hot carbolineum for fifteen minutes. In the central station's yard the poles were shaved and given two coats of green paint above the ground line. They were then set in the 1-mile line with 110-ft. spans and carry the following circuits: Four 4000-volt, three-phase, four-wire, No. 0 circuits; one 4000-volt, three-phase, four-wire, No. 6 circuit; one 1000-volt, three-phase, four-wire, No. 4 circuit; eight street-lighting No. 6 circuits; and four street-railway, 500,000-circ. mil circuits. It is estimated that these lines alone, without the hardware, insulators or cross-arms, make up a load equal to about 1400 lb. per span.



EVANSVILLE (IND.) POLE LINE LOADED TO ABOUT 1400 LB. PER SPAN

SIGN GUIDE & GRIPPER

Smoke Signal System Used by Pittsburgh Company

An interesting installation has just been completed at the Brunots Island power station of the Duquesne Light Company of Pittsburgh, Pa., as a further aid in the abatement of smoke. Not only has the light company done much in an indirect way to eliminate the smoke nuisance by shutting down many of the smoky stacks in the heart of the city through the substitution of its electric service, but in a direct way by using every practical means of reducing the amount of smoke emitted from its own power stations, even though the stations are located far from the business and residential districts.

In the Brunots Island station the tops of the stacks are not all visible from the boiler room, and it was to give each fireman a knowledge of the condition of the stacks serving his boilers that the following system was installed. The essential part is an observation room located out in the yard in such a position that each of the eighteen stacks is visible. In that office is an elaborate switchboard with lights which are controlled by the stack observer. Connecting the smoke observer's office with the boiler room are forty wires inçased in a lead covering, by means of which red lights located in the firing aisle of each stack are operated. Gongs are also used to attract the attention of the firemen as soon as any smoke appears. Located in the observer's office are also recording instruments which show exactly how long the stacks smoke and the time of the smoking.

Graphical Analysis of Steam Plant Design and Operation

A graphical method of accurately estimating the cost of producing power under given conditions, and predetermining the effects of changes in operating conditions or equipment on plant performance, was outlined by R. J. S. Pigott at the recent meeting of the A. S. M. E. It consists of plotting the input-output curves for main units, exciters, boiler-feed pumps, forced-draft fans, stoker drive and boilers and then combining them on one chart plotted between B.t.u. input and

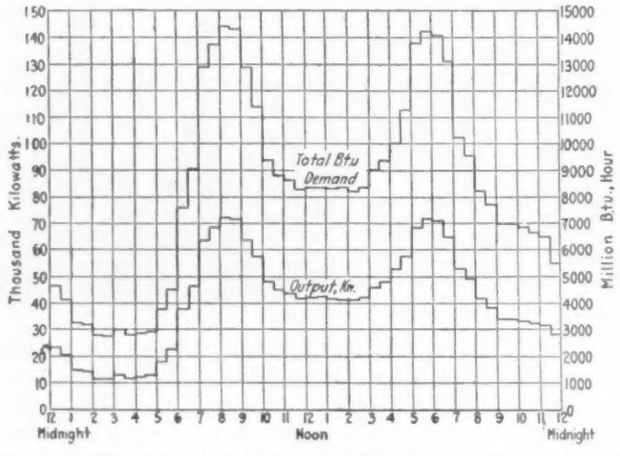


FIG. 1—ANTICIPATED LOAD CURVE WITH HEAT INPUT BALANCED

kilowatt output to correspond with the method of operation. From this chart the best method of utilizing the exhaust steam can be ascertained and by reference to the actual or anticipated load curve the required heat input can be determined. In explaining typical applications of this method extensive use was made of Willans lines. For a particular case curves were plotted for different items, indicated by the following numbers:

For (1) main units, curves were plotted between different electric loads, total steam per hour and steam per kilowatt-hour; for (2) exciters, between the same units and in addition B.t.u. per pound of exhaust and total B.t.u in exhaust; for (3) pumps, between boiler load and pump steam consumption per hour, B.t.u. per pound of exhaust; for (4) fans, between air output and steam per hour, and also between boiler output and fan brake horsepower discharge in cubic feet per minute and static pressure. By combining the curves (4) the

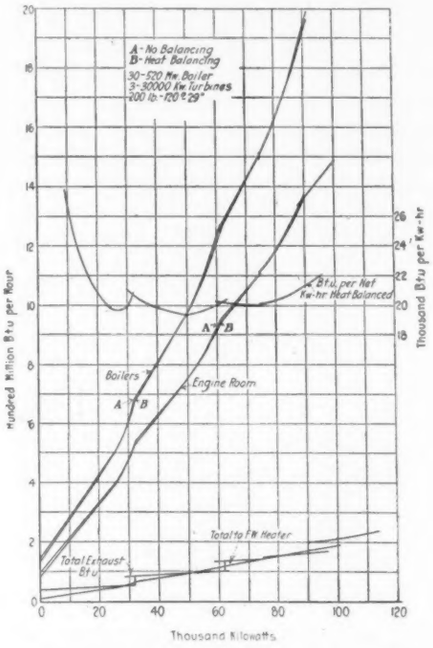


FIG. 2—PLANT INPUT-OUTPUT CURVES

relation between fan steam consumption and boiler output (5) was obtained. For (6) boilers the usual efficiency curves were plotted.

No input-output curves are needed for condenser auxiliaries, as they usually operate at constant load. By determining how many boilers would be needed for different steam outputs and how many should be banked, if any, the B.t.u. input for different boiler outputs (7) were plotted. By similar analysis and making use of curves (3) and (5) the input (8) to boiler-room auxiliaries was plotted for different boiler outputs. On the same chart (8) was plotted the heat available from auxiliary exhaust at different boiler loads. Since the stokers were operated by the fan drive, no curves had to be plotted for these auxiliaries.

Again, by arranging the prime mover input-output curves (1) end to end on a chart (9) to correspond with the points at which they are cut in, the prime-mover input-output relations for any load was obtained. Adding the constant input for the condenser auxiliaries, and the boiler-room auxiliary inputs (8) to these curves gave the total input (9) to prime movers and auxiliaries for different loads. From this information the input to the boilers at different electrical loads was calculated and plotted on the same chart (Fig. 2). At the bottom is plotted the heat required to heat feed water at different loads, and overlapping this is a jagged curve representing the heat exhausted by auxiliaries. If the auxiliary drive is so selected or operated that the exhaust heat is just sufficient for feed water heating requirements when the receiver pressure and auxiliary exhaust pressure are the same, then there will be an automatic heat balance. For instance, at light loads when the auxiliary exhaust is more

than required for heating feed water, the receiver pressure is less than exhaust pressure, so the surplus steam will be utilized by the low-pressure turbine. On the other hand, during heavy loads when the auxiliary exhaust is insufficient the receiver pressure is higher, so steam is bled into the feed water heater supply.

The effect of introducing or removing steam from compound turbines can be determined by plotting the Willans lines for the high and low-pressure turbines. For instance, the available from the exhaust can be determined from Fig. 2 and reduced to pounds of steam per hour at the particular receiver pressure. From the water rate under the particular load conditions the increase in capacity of the low-pressure turbine can be calculated. From the Willans lines for the high-pressure turbine the decrease in capacity due to increased receiver pressure can also be calculated. The difference between the gain and loss in low and high pressure capacities thus gives the net gain by introducing exhaust steam without increasing the high-pressure steam admitted to turbine.

Electric drive of auxiliaries is thermally less economical than steam drive with heat balance and in addition requires slightly more investment per kilowatt of plant rating. The advisability of using steam-electric drive, that is, motors receiving energy from turbo generators used to operate them only, depends on the load factor, increased cost of labor and maintenance. It may be pointed out that this arrangement is not as reliable as straight steam drive due to the two additional links inserted.

Motor Drive Arrangements in a Colorado Lumber Mill

Examples of arrangements which have been made at the D. C. Donovan Lumber Company, Longmont, Col., to avoid overhead shafts and obstructing belts are shown in the accompanying illustrations. In Fig. 1 is shown a 12-in. jointer belt driven by a 5-hp. Westinghouse motor installed on the floor. Connected with the same motor by means of a friction drive is a single-spindle shaper. This arrangement permits independent or simultaneous operation of both machines. The wood frame rip saw shown in the background is individually driven by a 7-hp. Westinghouse motor.

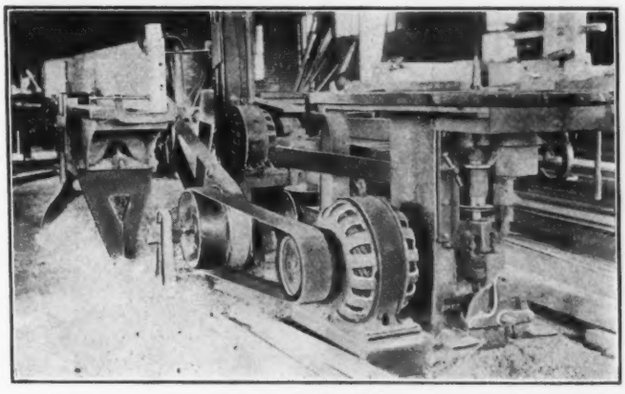


FIG. 1—METHOD OF DRIVING JOINTER AND SHAPER

Space was saved in providing for the planer and molder drives shown in Fig. 2, by using one motor, installing it in a niche in the wall, connecting by belt with the planer and by an underfloor shaft with the molder. This arrangement permits independent or simultaneous operation of the machines. The motor is a Wagner unit rated at 10-hp., the planer, which is on the right, measures 24 in. and the molder on the left is a 7-in. machine.

The remaining motors in this mill consist of a 3-hp. Westinghouse and a 5-hp. Wagner unit. The first is belt-connected to a 34-in. band saw and by means of another belt on the other end of the motor shaft can be connected with a 16-in. lathe and a double-end emery grinder. The 5-hp. motor drives the only overhead shaft

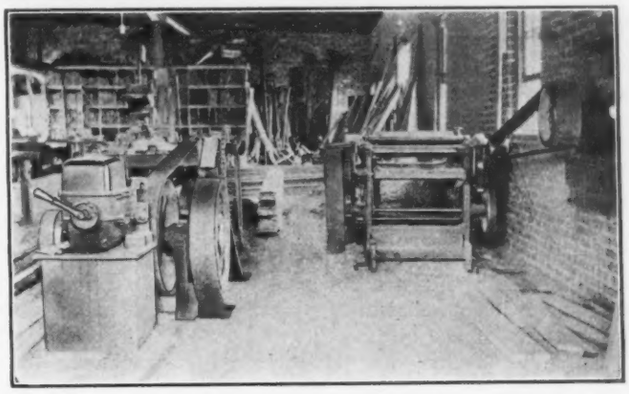


FIG. 2—MOTOR DRIVE ARRANGEMENTS FOR PLANER AND MOLDER

in the mill. From this may be operated at will a combination cut-off saw, a No. 1 tenoner, a No. 2 mortiser and borer and an arm sander.

Charles E. Nowels, manager of the mill, is enthusiastic over motor drive and states that the last mentioned shaft will be removed as the plant expands and individual drive used exclusively. Aside from the usual advantages attending individual drive, there is the absence of any obstruction to moving lumber and added safety due to reduction in moving parts. This plant operates twelve months a year, the energy consumption never being more than 400 kw.-hr. per month which at the 3-cent rate secured makes power cost only $12 a month. "If someone were to present us with an engine," says Mr. Nowels, "we could not afford to pay a man to shovel the coal."

Tests to Detect Grounds on Consumer's Circuits

About the most simple and effective means for detecting grounds on a consumer's circuit is to turn on all the lamps, apparatus or whatever the consumer may have connected to the service. After this has been done, back out the house wires of the meter and connect them together. Then connect one lead of the test lamp to one side of the incoming line and the other lead to the house wires. Should a ground exist, the test lamp will glow proportional to the resistance of the ground. Should the ground be so small that it cannot be detected by the test lamp, a rotating standard can be employed, connecting the current coil most suitable for the test. By checking a given number of revolutions of the rotating standard by means of a stop watch the wattage consumed by the ground can be determined. In the case of direct current a millivolt meter or a voltmeter should be employed.

Another method that is often used is to always make it a point to connect the current coil of the meter in the outside wire. As the neutrals are nearly always grounded at the transformer, a ground on an outside wire on the customer's premises will show in a rotation of the meter disk with all load removed. Most companies make it a part of the routine work of each meter inspector and tester to make tests on every inspection, regardless of reasons given for it.

COMMERCIAL AND BUSINESS POLICY

A Department of Plans and Methods for Widening the Application of Electricity and for Extending Electric Service

Auditorium and Model Kitchen for Use of Women's Clubs, Features of New Electric Building at Ithaca, N. Y.

One of the features of the new three-story office building recently put into service by the Ithaca (N. Y.) Gas and Electric Corporation is an auditorium on the third floor which seats 250 people and the free use of which has been extended to the various women's organizations of the city.

A model kitchen has also been installed near the auditorium. The company furnishes dishes for use at social gatherings, and the whole equipment is tendered absolutely free to any women's organization that may care to use it. Light, heat and the use of a piano and motion picture machine are also furnished gratis by the company.

Further attention to the interests of the feminine public is found on the first floor, where a spacious and well-appointed rest-room is located. Telephones, lavatory, writing table and comfortable chairs are parts of the equipment, and the efforts of the company to please have been enthusiastically received.

The cashier and the information department are located on the first floor, where also is the display of electric and gas fixtures and appliances. This floor is of tile, with marble baseboards. Showcases have been built around the various pillars, and the displayed appliances are mounted on glass shelves, making the highly polished appliances appear to stand out in space. In order to reach the cashier's desk the visitor to the office must pass these cases, and in addition to effecting space economy the display attracts the eye on account of its unusual character.

Meeting Gas-Engine Competition on a Basis of Motor-Operating Cost

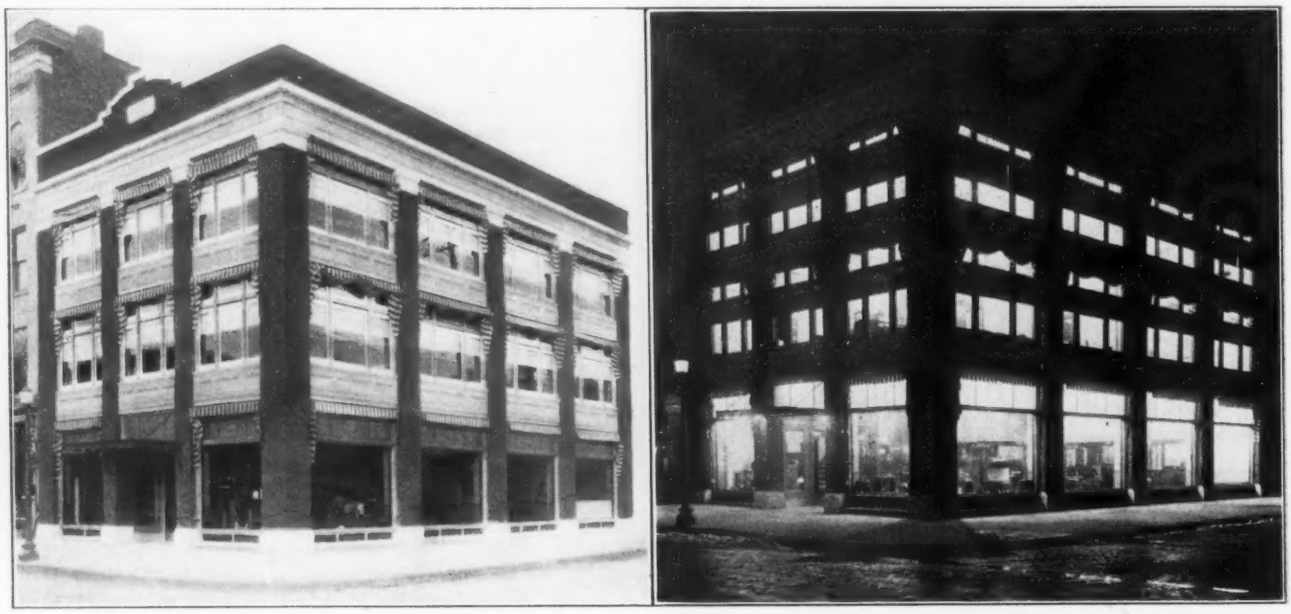
BY M. W. EHRLICH

Throughout certain sections of the United States the central-station power man has to meet the competition of the gasoline engine. These engines are extensively used in irrigation and mining work, the general run of installation ranging in size from 6 hp. to 30 hp., and averaging about 15 hp. From the nature of the work it is clear that the load factor runs high, operation in some instances continuing twenty-four hours a day. However, the average-size gas-engine plant is run but ten hours per diem, using for fuel a cheap distillate which ranges in cost from 12 to 18 cents per gallon, according to location.

TABLE I—COST PER HORSEPOWER-HOUR, IN CENTS, FOR GASOLINE-ENGINE PLANTS

Size, Horsepower	100 Per Cent Load Factor		50 Per Cent Load Factor		33⅓ Per Cent Load Factor	
	Fuel	Total	Fuel	Total	Fuel	Total
6	2.4	4.3	3.1	5.9	3.5	7.2
10	1.9	3.2	2.5	4.4	2.8	5.3
12	1.8	3.0	2.3	4.2	2.7	5.2
16	1.6	2.5	2.0	3.5	2.4	4.3
22	1.5	2.4	1.9	3.2	2.2	4.0
30	1.4	2.2	1.8	3.1	2.1	3.8

That the owners of gasoline engines in these sections are ready to welcome any other form of power, providing the cost is no higher, may be proved by a casual observation of existing operating conditions. Inter-



ATTRACTIVE CORNER MADE BY NEW ELECTRIC BUILDING AT ITHACA, N. Y.

An auditorium and model kitchen on the third floor of this building are offered gratis to any women's organization in Ithaca desiring to hold meetings or social functions as the electric company's guests. The illustrations show the attractive exterior appearance of the building by day and by night.

views will verify that there is no end of trouble in the form of breakdowns and other inconveniences with the gasoline engine.

FACTS NEEDED TO CONVINCE OWNERS

These facts having been established by a canvass of numerous engine operators, led the commercial manager of one Western central station to believe that only by facts and figures could these owners be convinced that electricity purchased from its lines would be just as economical and in many instances considerably lower in cost. In this plant alternating current is generated by large Diesel oil engines.

The first step in this campaign was to gather data on

TABLE II—COMPARISON OF FIRST COSTS OF GASOLINE ENGINES AND ALTERNATING-CURRENT MOTORS

Size, Horsepower	Gas-Engine Plant	Electric Motor	
		Cost	R.P.M.
5	$250	$110	1800
10	460	185	1800
15	620	250	1200
20	800	290	1200
30	1150	350	1200

cost of equipment and operating expenses of gasoline-engine plants. These were analyzed and compiled, the operating cost being computed for various load factors, showing the cost per horsepower-hour for ten-hour operation varies from 2.2 cents to 7.2 cents, giving an average of 3.5 cents per horsepower-hour for a 16-hp. plant at 50 per cent load factor. The various costs for different-sized installations, as computed for various load factors in gasoline-engine plants, are given in Table I, which lists the cost of fuel and supplies in one column, and the total cost, including labor and fixed charges, in another.

With this information, another tabulation was prepared showing the first cost of different-size alternating-current motors as compared with gasoline engines. The results obtained in comparing the smaller units are shown in Table II, the motors costing considerably less than the corresponding gas engine plant. With the electric motor, not only is the initial cost lower, but the maintenance and depreciation charges are also less than those for the gas power.

MOTOR AGENCY CONTRACT PRICES

A motor agency was secured to take advantage of any contract prices, thus obtaining a 10 per cent reduction. This enabled the company to sell motors at the prices given in Table II, which are for three-phase machines suitable for 110, 220, 240 or 500 volts. For larger motors, slow-speed units at 2200 volts were recommended at the following contract rates: 50 hp., 900 r. p. m., $610; 75 hp., 900 r. p. m., $760; 100 hp., 720 r. p. m., $990; 150 hp., 720 r. p. m., $2,275.

To these prices 10 per cent was added in fixing the customer's cost.

All these figures were compiled in handy form to fit the salesmen's notebooks, and a copy was given to each man sent out to solicit new business.

It was not hard, of course, to convince those contemplating new installations that an electric motor would be more satisfactory than a gasoline engine, owing to its simplicity, ease and economy in operation, and this at a lower first cost, and to shut down existing plants it proved only necessary to show at what cost the central station could supply the energy and at what price the motor could be installed.

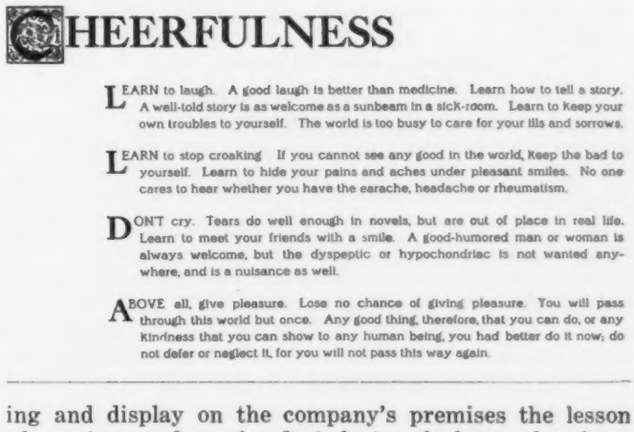
Results from Farm-Line Business in Kansas

According to C. A. Leland, Jr., electrical superintendent for the Atchison (Kan.) Railway & Light Company, farmers have not been found to be particularly good customers, but under some conditions the business is not unprofitable. The average consumption per year for five farmers on one of the company's lines was 153 kw.-hr. At 12.5 cents this amounts to $19.12 per year.

These five farmers have 5 kw. in transformer capacity, figuring one 1-kw. transformer per customer. The iron loss from these transformer units would amount to 175 kw.-hr. per year, making a total of 328 kw.-hr. delivered to the transformers. Adding 10 per cent for the remaining line loss, 360 kw.-hr. per year would be delivered to the rural line. Since the cost of energy at the city limits is $0.0276 it may be seen that 360 times $0.0276 equals $9.94, the cost to deliver energy to the line. Subtracting $9.94 from $19.12 equals $9.18. This amount remains to take care of collections, office work, overhead, etc. In this case the farmers send or bring in their readings each month and pay their bills, so the company has no cost for reading meters. They also pay a rental of 50 cents per month to the owner of the line, which, in this case, is another town which is buying energy at Atchison. Although this is not a large return, under the circumstances the farmers are thought to be not unprofitable customers. Farmers on this line paid for the transformers, fuses, service, etc. A separate set of lightning arresters was not considered necessary for each transformer.

A "Cheerfulness Creed" for Company Representatives Who Meet the Public

Realizing the importance of keeping the need for courtesy and cheerfulness constantly before company representatives who come into contact with the public, many utility companies have, during the last few years, posted service and courtesy creeds in their offices where both employees and public could read them. By printing these creeds on cards and posters for office framing and display on the company's premises the lesson of courtesy and service first, last and always, has been driven one step further home. Extending this idea one of the large Western railroads has issued a "cheerfulness" creed, which has been posted in many of that company's offices and depots for the guidance of its own men in meeting the public. One of the cards is reproduced herewith with the suggestion that such a creed might well be adopted by electrical sales organizations and sales people as an excellent guide to business conduct.



CHEERFULNESS

LEARN to laugh. A good laugh is better than medicine. Learn how to tell a story. A well-told story is as welcome as a sunbeam in a sick-room. Learn to keep your own troubles to yourself. The world is too busy to care for your ills and sorrows.

LEARN to stop croaking. If you cannot see any good in the world, keep the bad to yourself. Learn to hide your pains and aches under pleasant smiles. No one cares to hear whether you have the earache, headache or rheumatism.

DON'T cry. Tears do well enough in novels, but are out of place in real life. Learn to meet your friends with a smile. A good-humored man or woman is always welcome, but the dyspeptic or hypochondriac is not wanted anywhere, and is a nuisance as well.

ABOVE all, give pleasure. Lose no chance of giving pleasure. You will pass through this world but once. Any good thing, therefore, that you can do, or any kindness that you can show to any human being, you had better do it now; do not defer or neglect it, for you will not pass this way again.

COST OF ELECTRIC COOKING

Detailed Investigation Made by Portland Company Discloses Interesting Facts

As the result of a year's detailed investigation into the cost of cooking by electricity, the Pacific Power & Light Company of Portland, Ore., has published interesting figures on the subject indicating that the average family can cook electrically for about $3 a month with energy selling at 3.6 cents net.

The Pacific Power & Light Company operates in a number of smaller cities and towns in eastern Oregon and Washington, where coal and wood are not plentiful. For several years it has made strong efforts to secure more of a cooking load, and during the year ended Sept. 30, 1916, it added sixty-five ranges to its lines, bringing the total number to 201. These ranges earned the company $4,927.31 net during the year, and they consumed 128,671 kw.-hr. The earnings per kilowatt-hour were 3.82 cents, which were slightly in excess of the unit rate because of the minimum charge bills that brought up the average. The average monthly number of ranges in service was 161, making the yearly earnings per range $30.60.

One Quarter of Cooking Bills for Dollar Minimum

During the year the company issued 1930 bills for range service, and of these bills 527 were minimum charge bills for $1 or less. This indicates that 27.4 per cent of the bills were for installations that were not used to their best advantage. It is this class of billing that the company is doing its best to eliminate, educating the customers away from considering their stoves as accessory and stand-by features only. Considerable progress has been made in this work, and it is believed that during the coming year the minimum charge bills will be less than 20 per cent of the total.

A still more undesirable feature of the business is the fact that some patrons fail to use their stoves at all, and yet pay $1 for the stand-by. During the year the company issued fifty-four of these minimum charge bills showing no energy used at all. This figure is included in the 527 minimum charge bills mentioned above. It is only by concerted efforts on the part of the local managers and solicitors that the undesirable minimum charge bills and stand-by bills can be eliminated.

Average Monthly Bill $2.55

The average monthly bill was $2.55 net. The company has deducted from the total all the minimum charge bills and their earnings, and finds that the average bill with minimums eliminated is $3.13 a month. The company feels that this is a more honest expression of the cost of electric cooking, because the minimum charge bills do not indicate that the range owners were really using these ranges to full capacity. About fifty of the ranges, or approximately 25 per cent, were used in connection with electric water heaters, operated with the range through a double-throw switch. No earnings from water heaters are included in the above statistics.

Starting Right with the Customer

When the United Illuminating Company of New Haven, Conn., installs a meter it mails a letter to the new customer telling of the various conveniences that electric service can bring to the home. The letter mentions the many uses of appliances, and a card is inclosed which by filling in and mailing the customer can obtain a two weeks' free trial of an electric iron or toaster.

Art Gallery Lighted by "Daylight" Lamps

The first installation of type C "daylight" lamps for art-gallery lighting in New York City has been installed at the Salmagundi Club, 14 West Twelfth Street. The Salmagundi Club is one of the oldest and best-known clubs in America, and its membership is composed chiefly of artists. The new lighting was installed about a week ago to light an exhibition of water colors and illustrations by members. Forty-eight blue-bulb "daylight" lamps of 150-watt rating were placed in the regular trough reflectors to take the place of the old tungsten lamps.

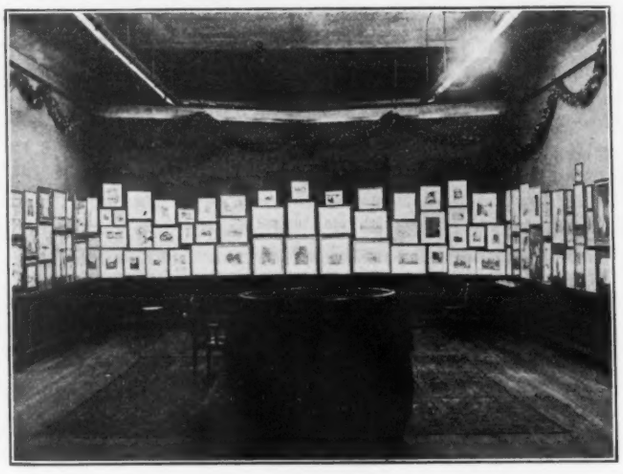


EXHIBIT AT SALMAGUNDI CLUB, NEW YORK, ILLUMINATED BY "DAYLIGHT" LAMPS IN REFLECTOR TROUGHS

A Co-operative Demonstration to Show the Public How Housewiring Is Done

A plan for a co-operative "House Electric" that will show the public the methods employed by the up-to-date electrical contractor in wiring a house for electric service is being worked out by an official of the commercial department of a New Jersey power company.

According to the plan now under way the electrical contractors of the community get together and after selecting an unoccupied, unwired house make an offer to the owner to wire it free in exchange for permission to exhibit the work for a period of ten days. A fixture supply house is designated to furnish equipment for the job, the owner of the house paying for the fixtures at list and the supply house turning the net profit into the common fund to meet the cost of the wiring and the subsequent exhibition.

One contractor is selected by the group to supervise the wiring and the cost is borne by the others on a pro-rata basis determined by the number of men employed.

All dirt accumulated during the installation is to be left as made, and where floor boards have been removed they are to be left up. Canopies of fixtures are to be left down and one or two switches left out of the boxes to show the box construction.

The building is to be extensively advertised and a representative of the central station and contractors will be in attendance daily from 10 a. m. to 10 p. m.

A sign calling attention to the building on exhibition will be displayed in the office of the central station, and a similar sign placed in front of the house which is on display.

In the case referred to, the local real estate dealers were found to be very ready to co-operate in the scheme, especially where the house selected is on the market.

ADVANCE IN TECHNICAL THEORY AND PRACTICE

Including a Digest of Important Articles Appearing in the Scientific and Engineering Press of the World

SENSIBILITY OF THE EYE TO VARYING DEGREES OF LIGHT

Effects of Glare and Contrasts in Brightness Levels Studied to Determine What Is Good Lighting

THE eye is the sole means of distinguishing good lighting from poor lighting. It is therefore of the utmost importance that the effects of light on the eye be determined as accurately as possible so that the illuminating engineer may design lighting systems that are efficient and at the same time comfortable to the eye. Considerable work has been carried on in this direction, the past two years, in the Research Laboratory of the Eastman Kodak Company by Dr. P. G. Nutting. Although this laboratory was founded primarily for the purpose of investigating photographic problems, a study of the eye presented many interesting aspects closely allied with the theory of photography, and for that reason work on the subject was undertaken.

As is well known, the eye accommodates itself to certain changes in lighting conditions with much facility,

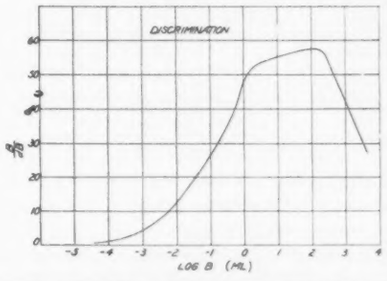


FIG. 1—CURVE SHOWING ABILITY OF EYE TO DETECT JUST NOTICEABLE DIFFERENCES IN BRIGHTNESS AT VARIOUS LIGHTING LEVELS

while with others it either works with difficulty or even does not function at all. One of the chief objects of the research on the eye has been to determine to what brightness levels and changes the eye most readily and with the greatest comfort and precision adapts itself. The ideal lighting is, of course, out-of-doors daylight lighting, lighting that is well diffused with no great contrasts anywhere. With artificial illumination the light usually comes from single directions, causing shadows and contrasts far in excess of those generally met with in the open. An increase in contrast decreases the sensibility of the eye, and it is very important to know just what degree of contrast is permissible in a given case so that the eye will operate with the least amount of irritation and smallest decrease in efficiency.

In studying the lighting conditions met with in ordinary life one may put the different kinds of lighting into four general groups as follows: (1) Exterior daylight with a mean brightness level of 1000 millilamberts; (2) interiors in daylight, 10 millilamberts; (3) interiors at night, 0.1 millilambert, and (4) exteriors at night, 0.001 millilambert. The research on the eye has been directed chiefly toward work on sensibility to brightness glare, to contrast and to lowest perceptible brightness (threshold sensibility).

The sensibility varies considerably in the four groups mentioned above. For instance, the brightness difference just noticeable in closely adjacent fields for a brightness level of 1000 millilamberts (average brightness of objects out-of-doors in full sunlight) is 0.0175, while for the 10 millilamberts level it is 0.030, for the 0.1 millilambert level, 0.123, and for the 0.001 millilambert level, 0.79. The instantaneous threshold in each

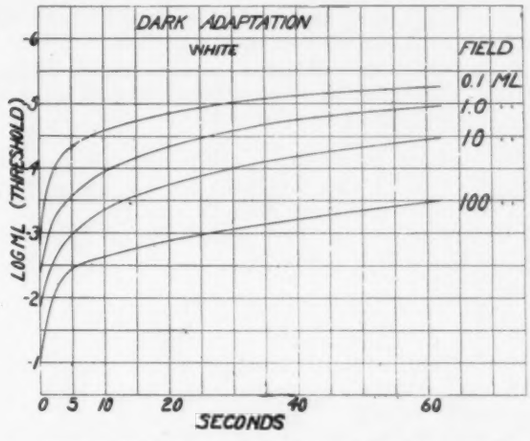


FIG. 2—TIME REQUIRED TO ADAPT THE EYE WITH WHITE LIGHT TO LOWEST LIGHTING LEVELS PERCEPTIBLE WITH DIFFERENT SENSITIZING FIELDS

case is 0.35 millilambert, 0.017 millilambert, 0.0014 millilambert and 0.00011 millilambert. These figures show that as the brightness level is decreased from that of out-of-doors daylight lighting the sensibility of the eye decreases. Taking the sensibility of the eye as unity at exterior daylight brightness the relative sensibility to glare is 200 for interiors in daylight, 18,000 for interiors at night and 160,000 for exteriors at night. Similarly the relative contrast and threshold

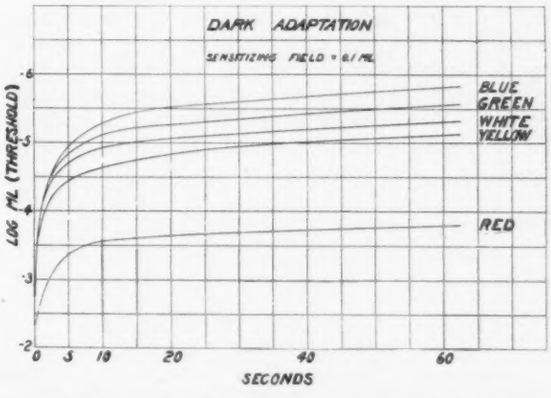


FIG. 3—DARK ADAPTATION CURVES FOR COLORED LIGHT

sensibilities are 1, 60, 1400 and 22,000 respectively and 1, 20, 350 and 3100 respectively.

A good part of the work on the eye was done with a visual "sensitometer," which consists of a large white cardboard with a small square opal-glass window in the middle which is illuminated from the rear by a Nernst lamp operating on a direct-current circuit of 160 volts.

A double lens is utilized to throw the image of the lamp on a slit. After passing through the slit the beam spreads and illuminates the small window. The intensity of the light is controlled by a black wedge which slides in metal ways past the slit. The wedge consists of a rectangular sheet of glass coated with a mixture of black dye and gelatine of varying thickness. At one

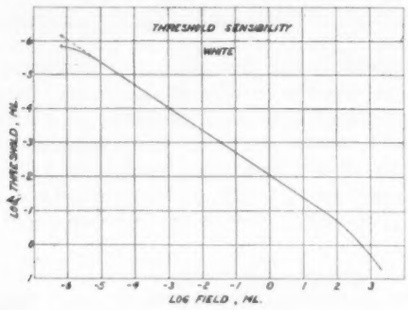


FIG. 4—RELATION OF LOWEST LIGHTING LEVELS INSTANTANEOUSLY VISIBLE TO BRIGHTNESS LEVELS TO WHICH THE EYE WAS PREVIOUSLY ADAPTED

end the coating is about a millimeter thick and is opaque, the opacity and thickness decreasing uniformly until at the other end clear glass is obtained. The coating is so arranged that the percentage of light transmitted by the wedge per unit of length can readily be obtained.

The observer faces the white cardboard at a distance of about 15 in. Back of the observer is placed a lamp of known rating, which is connected to a direct-current 115-volt circuit, for illuminating the large white field. The intensity of this lamp can be decreased to any value desired by means of light filters, which consist of sheets of gelatine dyed to the opacity required for transmitting the amount of light needed.

The brightness of the test field, which is that part of the illuminated opal glass showing through the square hole in the cardboard and of the surrounding field which is illuminated by the lamp behind the observer, can be measured at any time by a brightness photometer. This device is a small boxlike affair equipped with a battery-operated lamp. Through a small peephole one may view two very small rectangular windows placed side by side, the one being illuminated from the outside and the other by the miniature lamp. The amount of light coming from the miniature lamp can be decreased by a shutter connected to a movable hand on the outside of the box which travels over a scale calibrated in foot-candles. The readings can be changed to lamberts and millilamberts by multiplying them by a constant. The shutter is shifted until the illumination of both windows is the same. At this point a read-

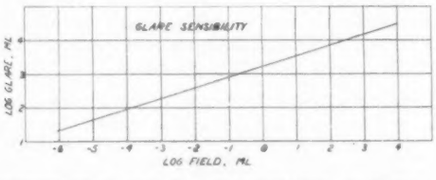


FIG. 5—BRIGHTNESS THAT JUST BECAME PAINFUL (GLARY) WITH EYE PREVIOUSLY SENSITIZED TO DIFFERENT LIGHTING FIELDS

ing is taken which indicates the brightness of the outside field.

In the original photometer used the small test windows were arranged concentric to each other. With this arrangement, however, the fovea or center of vision favored the inner window, so to speak, and there was a tendency not to match accurately the brightnesses of the two windows. With the rectangular windows as adopted in the Kodak Research Laboratory the dividing line bisects the center of the two adjacent fields taken as a single field, and although the brightness near the middle of this center line may appear different from that at the outer edges, what brightness is apparent in one part of one window, when the two are correctly matched, is also apparent in the same part of the other window.

Readings were taken with a number of observers. Before starting any experiment, however, each observer was kept in a dark room from fifteen to twenty minutes so that the eye would be affected as little as possible by previous conditions. Even then much depended on what the observer had been doing hours before. From data taken and curves plotted therefrom, in the afternoon it could be determined whether the subject had worked in a dark room during the forenoon. It was also found that a person who does considerable work in a dark room "gets his eyes" much more rapidly than one who does not, but according to data obtained the final maximum sensibility is no higher.

The sensibility of the eye to minimum contrast (brightness difference just noticeable in closely adjacent fields) was determined by first making the test field and surrounding field of the sensitometer of the same brightness and then moving the wedge until a difference in brightness between the large and small field is just perceptible. A curve was plotted (Fig. 1)

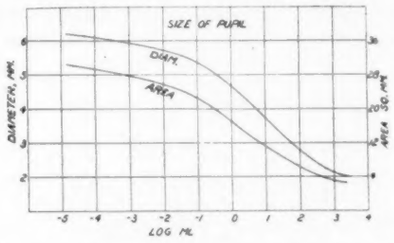


FIG. 6—VARIATION OF SIZE OF PUPIL TO VARYING LIGHTING LEVELS

with the logarithms of brightness as abscissæ and the field brightnesses divided by the just noticeable differences (discrimination factors) as ordinates. The abscissæ are given in logarithms because of the great range of brightness values. Since good seeing is said to be determined chiefly by the ability to distinguish details differing but slightly in brightness, the curve is especially useful because it shows just at what brightness levels the eye can detect the smallest differences; in other words, the greatest amount of detail in high light, half-tone and shadows.

The difference sensibility curves vary according to the amount of time to which the eye has been adapted to the large field. This is in accord with one's experience when he passes suddenly from a light room to a dark room or vice versa—the eye requires time to adapt its sensitivity to the new brightness level. Similarily, if a searchlamp is suddenly flashed in one's eyes at night time when the eyes are adapted to a very low level, the light appears very blinding, whereas if the lamp's beam is turned toward the eyes in bright sunlight, when the eye is adapted to a much higher level, it is scarcely noticeable.

Fig. 2 gives one an idea of what eye adaptability is for white light with initial brightness of 0.1 millilambert, 1 millilambert, 10 millilamberts and 100 millilamberts. Fig. 3 shows dark adaptation curves for different colors with a sensitizing field for each set of readings of 0.1 millilambert.

The discrimination and dark-adaptation curves also give one an idea of how the eye is acting when pass-

ing rapidly along an unevenly illuminated street. The eye adapts itself more quickly in brighter places, it has been found, than it does in dark localities; with even illumination its sensitivity is much greater. Again, in viewing any field exhibiting heavy contrasts, such as a machine shop, for instance, where one's attention wanders continually from dark patches to glary

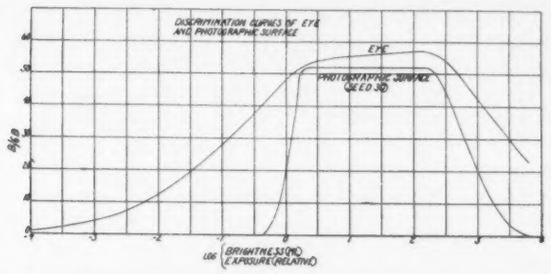


FIG. 7—CURVES SHOWING RELATIVE SENSIBILITY OF THE EYE AND PHOTOGRAPHIC PLATE TO VARYING LIGHT

surfaces, the sensibility of the eye is lowered, and consequently it is necessary to increase the intensity of the illumination.

In Fig. 4 is shown a curve plotted from data obtained by the threshold method with white light. Readings were taken by adapting the eye to a certain level with the large field and then suddenly substituting a brightness in the small field that previously had been found to be just perceptible. This instantaneous threshold, as it is called, indicates the state of the retina at any point. The curve is a straight line excepting at the extremities. The bending off near the threshold is due to the difference in the size of the two fields. At high intensities the falling off in the linear relation indicates a decrease in retinal sensibility. In the region of ordinary brightness there is a slight dip, showing that here the eye is more sensitive.

In getting data on glare sensibility the eye was adapted to a certain brightness level and then suddenly exposed to a light that appeared just uncomfortably bright. A straight-line curve was plotted from the glare-sensation readings as shown in Fig. 5. This curve can only be continued to a point where the sensitizing field itself appears glaring where adaptation ceases. This point was found to be at about 52 lamberts, which is five times as bright as white paper in direct sunlight. The readings were repeated with a number of observers and remarkably uniform results were obtained. They tell just what overload the retina can withstand. The data on glare also show very clearly why the light from a searchlamp or a headlamp of an automobile or locomotive is so blinding at night time and scarcely noticeable in the day.

In Fig. 6 are illustrated two curves which show how the diameter and area of the pupil of a normal eye decreases as the intensity of light increases, the pupil contracting automatically to protect the retina from the increased amount of light. The diameter varies from about 2 mm. to 8 mm. On being suddenly exposed to a bright light, a second is required for the pupil to contract to a size which is normal for the new brightness level; when a sudden lowering is made in the brightness the pupil expands to a diameter of 5 mm. in two seconds, and then continues to expand slowly to the limit.

Fig. 7 illustrates the eye discrimination curve shown in Fig. 1, and for comparison purposes a curve which shows the effect of short exposures of varying intensities on a photographic plate. As can be seen, the eye is far more sensitive with low intensities of light than the photographic plate.

The data obtained by the experiments on the eye as outlined are of immense value to the illuminating engineer. They show that contrasty fields are to be avoided wherever possible; if heavy contrasts are unavoidable the fields have to be illuminated to much higher brightness levels than would be necessary where moderate contrasts prevail. A study of the curves will also readily show why indirect or semi-direct illumination with the consequent elimination of the glare of light sources is preferable to direct lighting, and why white ceilings, light-colored walls and absence of dark furniture and glossy surfaces are necessary to reduce the amount of excessive contrast.

The experiments on the sensibility of the eye are being continued, new observers being used in many cases to carry on experiments performed before so as to check the results obtained so far.

Generators, Motors and Transformers

Effect of Barometric Pressure on Temperature Rise of Self-Cooled Transformers.—V. M. MONTSINGER.—A standard rating applies only when an electrical machine is installed in a temperature location and at a moderate altitude. For service in a tropical climate or at a great altitude, an electrical machine must be re-rated, as otherwise the temperatures attained may exceed approved values. The author deals with the influence of altitude and discusses the effect of altitude upon the temperature rise of oil-immersed transformers without water cooling. Tests are described which were made successively at Pittsfield, Mass., whose altitude is 305 meters; at Boulder, Col., where the altitude is 1830 meters, and at Leadville, Col., where the altitude is 3360 meters. For some kinds of transformer tanks the temperature rise at this greatest altitude exceeded that at Pittsfield by some 12 per cent. It is quite evident that a variation of so considerable magnitude cannot be ignored. Formulæ are developed by the author which will enable the effect of altitude to be accurately taken into account, and he recommends their inclusion in the A. I. E. E. standardization rules. The present recommendations concerning altitude in the American and British rules are shown by the author to be inapplicable for transformers immersed in oil in tanks of the types which were employed in the tests at Pittsfield, Boulder and Leadville. The chief results of the investigation are summed up as follows: Within a limited range of temperature, namely, from about 40 deg. to 80 deg. C., loss by radiation varies approximately

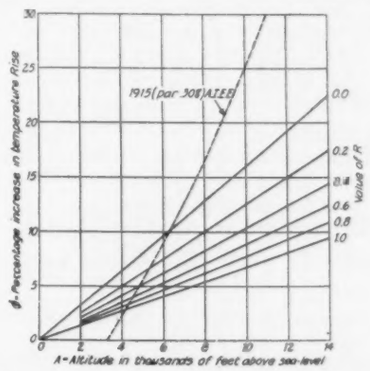


FIG. 8—CURVE SHOWING EFFECT OF ALTITUDE OR HEATING OF DIFFERENT SHAPE TANK SURFACES

as the 1.12 power of the temperature rise. Loss by convection varies as the 1.25 power of the temperature rise. For self-cooled transformers having tanks with irregular contours, the total loss dissipated usually varies as the 1.25 power of the top oil rise. For transformers having smooth surfaces the loss varies close to the 1.15 power of the top oil rise. Radiation is not

affected by barometric pressure. Convection varies approximately as the 0.5 power of barometric pressure. Or stated in another way, for a constant loss, the temperature rise varies inversely as the 0.4 power of the barometric pressure. For a constant loss supplied to tanks having different shaped surfaces, the effect of altitude on the temperature rise of top oil is expressed by the formula:

$$\phi_2 = \frac{1.46A}{1 \times 1.3R}$$

in which ϕ_2 = increase in temperature rise of top oil in percentage of rise at lower altitude; A = difference in altitude in thousands of feet; R = ratio of envelope area of tank surface to developed area of tank surface. For transformers having 40 per cent core loss and 60 per cent copper loss (which is increased with an increase in temperature due to higher altitude) the effect is to increase the constant 1.46 in the above formula to 1.6, so that we have:

$$\phi = \frac{1.6A}{1. + 1.3R}$$

Curves calculated from this equation for different values of R are shown in Fig. 8, together with a curve representing the A. I. E. E. (par. 308) rule.—*Gen. Elec. Rev.*, January, 1917.

Installations, Systems and Appliances

Grading of Starting Resistances for Series Motors and for Series-Parallel Control.—F. T. Chapman.—In practical work the value of the number of steps in a rheostat is often fixed by the type of controller to be used in a particular case, or the choice is between two or three values at the most. The value of the maximum current employed during the starting period is fixed fairly definitely by conditions all together apart from the starter. With the number of steps and the maximum current fixed the problem is to determine the minimum current and the values of the resistance steps. The author describes a simple method which has some novel features. The speed-current curve is made use of.—London *Electrician*, Dec. 8, 1916.

Magnetic Control for Miscellaneous Apparatus.—C. W. Gammons.—In this, the sixth installment of the series on industrial control, applications of magnetic control apparatus are described, which have been thoroughly standardized. Photographs and complementary wiring diagrams of the various types of apparatus are given with explanations of the sometimes intricate functions of the different parts of the equipment. In particular, the article treats of starters for squirrel-cage, form-wound, single-phase and direct-current motors, and equipments for master switches, valve control, arc-furnace control, and arc-welding control.—*Gen. Elec. Rev.*, January, 1917.

Starting Rheostats.—Campanakis.—A mathematical article illustrated by diagrams on the calculation of starting rheostats with oil.—*La Lumière Elec.*, Dec. 9, 1916.

Electrochemistry and Batteries

Fixation of Atmospheric Nitrogen.—Helen R. Hosmer.—A useful list of references to the extended literature on the nitrogen industries and the fixation of atmospheric nitrogen from 1912 to 1916.—*Gen. Elec. Rev.*, January, 1917.

Electrolytic Dissociation.—H. J. M. Creighton.—An article on electrolytic dissociation in non-aqueous solutions. The author considers it to be probable that the dissociating power of a solvent cannot be regarded as a well-defined physical constant, but that it must be considered as a specific property of the solvent, which has its origin in the physical constants existing between solvent and solute.—*Journ. Franklin Inst.*, December, 1916.

Units, Measurements and Instruments

Elastic Properties of Phosphor-Bronze Wires.—A. J. Oehler.—Former work on platinum-iridium wires when used as suspensions for torsion pendulums showed some remarkable elastic properties of that alloy. The principal one of these was the variation of the period with the amplitude of vibration. The present author has tested phosphor-bronze wires in the same way and found that there were three distinct states, from one to another of which the wires may change. Drawing of the wires has a tendency to increase the effect of a varying period with the amplitude. Both a long-continued vibrating and a long-continued annealing have the effect to change the state of the wire. The author concludes that phosphor-bronze wires are not desirable as delicate suspensions, in many cases where they are used. He thinks it is very probable that all alloys have their distinct peculiarities just as platinum-iridium wires and phosphor-bronze wires have been found to have.—*Phys. Rev.*, November, 1916.

Telegraphy, Telephony and Signals

Transformers in Wireless Telegraphy.—H. Chireix.—Numerous authors have developed equations for the charging circuit of wireless telegraphy stations operating in resonance, but have neglected in their calculations the influence of the magnetizing current of the transformer. The object of the present article is to take this effect into account. The author shows in particular how a poorly designed transformer may decrease the power of the wireless telegraph station and how it is possible to determine the best weight of copper for a given magnetic circuit.—*La Lumière Elec.*, Dec. 2, 1916.

Miscellaneous

Lord Kelvin.—Alexander Russel.—His Kelvin lecture before the (British) Institute of Electrical Engineers on "Some Aspects of Lord Kelvin's Life and Work." The author discusses Kelvin's early training at Glasgow, his work in electrostatics, the Cambridge period, his work on electric images, absolute units, electric oscillations, peristaltic induction, the Atlantic cable, sparking distances, vortices, the diffusion of heat, the cooling effect produced by a covering, age of the earth and sun, high-frequency resistance, and the activity of Kelvin as electrical engineer and as a teacher.—London *Electrician*, Nov. 17, 1916.

Electrification of Wool.—A discovery of some scientific interest is announced by Dr. S. A. Shorter, of Leeds University, who has been working on the electrification of fibers. Hitherto it has been generally assumed that such electrification, which is a source of trouble in textile processes, is due to friction. Dr. Shorter has established the fact that electricity can be evolved as a result of drying, accompanied by a subsequent lowering of the temperature. Among the suggested methods of getting rid of such electrification is the use of metallic discharging points or of ultroviolet light.—London *Electrician*, Nov. 17, 1916.

Photometer.—H. E. Howe.—A paper on a modification of the Hilger sector photometer method for measuring ultra-violet absorption and its application in the case of certain derivatives of fluoran.—*Phys. Rev.*, December, 1916.

Bonding of Electric Cables.—An article on the bonding and anchoring of electric cables with special reference to mining practice. A series of twenty-one sketches is given illustrating the different methods in use.—London *Elec. Review*, Dec. 8, 1916.

Men of the Industry

Changes in Personnel and Position—Biographical Notes

John B. Taylor of Watertown, N. Y., has been appointed president of the Wetmore Electric Company of Lowville, N. Y.

J. H. Gillis of Gloucester, Mass., has been appointed line superintendent of the Worcester Suburban Electric Company of Uxbridge, Mass.

T. S. Morrison of Asheville, N. C., has been elected president of the North Carolina Electrical Power Company of Asheville to succeed Captain W. T. Weaver, recently deceased.

E. L. Sellers, superintendent of the Kentucky Public Service Company at Frankfort, Ky., for the past three years, has been appointed manager of the Oneonta (N. Y.) Light & Power Company.

W. E. Brewster has resigned from the engineering department of the National Lamp Works of the General Electric Company, Nela Park, Cleveland, Ohio, to take up work with the Sperry Gyroscope Company of New York City.

P. A. E. Armstrong, who has been manager and chief engineer of Quasi-Arc Weltrode Company since its organization, has recently taken a managerial position with the North American Company with offices in New York City. He will take up new development work in an electro metallurgical line. Before being with the Quasi-Arc Company, Mr. Armstrong was steel expert for Bohler Brothers Styrian Steel Works, Sheffield, England.

R. G. Carroll, recently acting manager of the Eastern Texas Electric Company at Beaumont, Tex., has been appointed manager of the Key West (Fla.) Electric Company, to succeed I. M. Stover. Mr. Stover was recently assigned to the management of the Baton Rouge (La.) Electric Company which operates the electric-lighting, gas and street railway systems in Baton Rouge. Mr. Carroll has been in the employ of the Stone & Webster Company of Boston, Mass., for the past fourteen years, holding positions in Jacksonville, Tampa and Pensacola, Fla.; Boston, Mass., Minneapolis, Minn., and Fort Worth and Beaumont, Tex.

James D. Callery has resigned the presidency of the Pittsburgh (Pa.) Railways, but will continue to serve as chairman of the board of directors. The vacancy caused by Mr. Callery's resignation as president will be filled by Sumner L. Tone, now vice-president of the Duquesne Light Company, one of the subsidiaries of the Philadelphia Company, of which the Pittsburgh Railways also is a part. Mr. Callery has purchased a seat on the New York Stock Exchange and will associate himself with N. K. McMullin in the brokerage business. Mr. Callery has been president of the consolidated street railways of Pittsburgh since 1902. He is also vice-president of the Philadelphia Company and its subsidiaries, president of the United Traction, the Southern Traction Company, the Allegheny Light Company, the Pittsburgh Railways and subsidiary companies, and director of the Westinghouse Electric & Manufacturing Company.

F. B. Yamnicky, formerly vice-president and general manager of the Vacuu-Rite Lamp Company of Chicago, Ill., has severed his connection with that company.

Frank Hussey has been appointed general manager of the East Haddam Electric Light Company of East Hampton, Conn., succeeding J. T. Sherlock, who has been transferred to a similar position in Hadlyme, Conn.

George E. Squier has been appointed fuel engineer of the United Electric Light Company, of Springfield, Mass. His immediate duty will be to study the fuel supply of the company with the purpose of improving its quality.

Martin F. Coyne, of Portsmouth, N. H., who for several years has been connected with the Rockingham County Light & Power Company of Portsmouth, N. H., has been appointed manager of the New Market (N. H.) Electric Company.

Samuel B. Mott has been appointed manager of the Noblesville (Ind.) Heat, Light & Power Company to succeed John T. Kester, who resigned on Sept. 1. For seven years Mr. Mott was superintendent of the Noblesville company, and prior to that time he was the chief engineer at the Noblesville power plant of the National Carbon Company.

Walter P. Schwabe, who has just been elected a director and vice-president of the Northern Connecticut Light & Power Company of Thompsonville, Conn., has for the past eight years been general manager of the Connecticut company, and prior to taking that office he was employed by the Public Service Corporation of New Jersey in the capacity of district superintendent and agent.

W. P. SCHWABE

H. M. West has been appointed commercial manager of the Harrisburg (Pa.) Light & Power Company.

J. W. Ostertag has been promoted to the position of assistant commercial manager of the Harrisburg (Pa.) Light & Power Company.

T. D. Montgomery has been appointed manager of the New York office of the Cutler-Hammer Manufacturing Company, of Milwaukee, to succeed W. C. Stevens, who has taken up new duties as sales manager of the company at Milwaukee.

J. H. Sturge, assistant superintendent of the southern division of the Public Service Electric Company, at Trenton, N. J., has been appointed superintendent, succeeding Paul Lüpke, whose headquarters will hereafter be at Newark, N. J.

Emil A. Bechstein, for a number of years general manager of the Sandusky (Ohio) Gas & Electric Company, has been elected second vice-president of that company, succeeding P. A. Staples. Mr. Bechstein is also president of the Ohio Electric Light Association.

L. A. Nott, who for twelve years has been associated with the Pacific Coast sales department of the Standard Underground Cable Company, has become identified with the K-P-F Electric Company of San Francisco, manufacturers of high-tension pole-top switches, transformer and disconnecting switches.

E. W. P. Smith, who has been city electrician of Cleveland, Ohio, for the past three years, has resigned to become consulting engineer with the Elliott Electric Company, 322 Champlain Avenue, Cleveland. Mr. Smith was graduated from Colorado College in 1908. After a year of operating experience in the West, he entered the employ of the Westinghouse Company, at East Pittsburgh, in the railway engineering department. Early in 1914, he was appointed city electrician of Cleveland. During his term of office, a revision of the Electrical Code was prepared, and passed by the Council. Mr. Smith is chairman of the Cleveland Section of the American Institute of Electrical Engineers.

J. Walter Allen has been appointed electrical engineer of the Boston (Mass.) Elevated Railway, effective on Jan. 1, 1917. Mr. Allen is well known in New England electrical circles. He is a native of Newtonville, Mass., and after graduating in 1899 from the Massachusetts Institute of Technology entered the employ of the Boston Elevated Railway, spending four years in the cable testing department. In 1906 he was appointed assistant to the company's electrical engineer, and since Nov. 1, 1915, has been acting electrical engineer. Mr. Allen has had a close connection with the development of the electrical equipment of the Boston rapid transit and surface lines, and the establishment of the alternating-current system of generation and transmission, which to-day forms the backbone of the larger service rendered the metropolitan community.

NEW APPARATUS AND APPLIANCES

A Record of Latest Developments and Improvements in Manufacturers' Products Used in the Electrical Field

Overload Relay for Compensators

The Condit Electrical Manufacturing Company of South Boston, Mass., has developed the overload relay shown here in which the contacts are separated by the movement of two armatures whose actuating coils

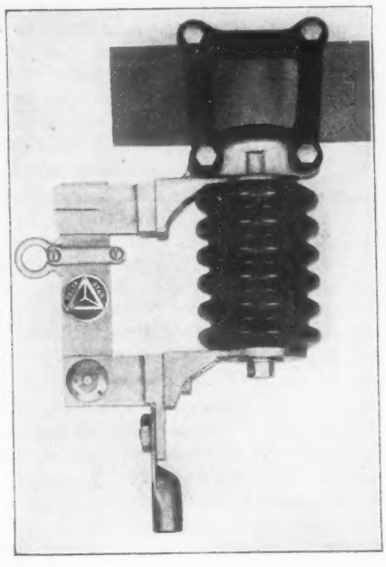
OVERLOAD RELAY FOR USE WITH COMPENSATORS ON SQUIRREL-CAGE MOTORS

are connected in series with the line when the compensator is in the running position. Upon the occurrence of an overload or a sustained short-circuit, the coils of the relay are energized, causing the armatures to be drawn up, thereby separating the relay contacts and opening the circuit of the under-voltage coil of the compensator, thus automatically throwing the compensator to the "off" position. The entire device is inclosed in a neat dull-black, dustproof metal case which also serves as a protective covering for the contacts, series coils, calibration tubes and time-limit attachments. The upper portion of the case is removable for inspection of the contacts. By removing the lower part of the casing which incloses the calibration tubes, the relay may then be adjusted for any value of current within its rated range.

The series coils of the relay are covered by the central section of the casing. The ends of the coils are brought out through the slate base and terminate in lugs to which the line wires may be attached. Each coil is fitted with an oil dashpot time-limit attachment which prevents the relay from operating on momentary fluctuations of load, but which does not interfere with its operation on a short-circuit or sustained overload.

Bus-Type Disconnecting Switches

Disconnecting switches placed in series with the busbar side of high-tension oil circuit breakers or switches that enable the operator to adjust or inspect the breaker mechanism without



DISCONNECTING SWITCHES FOR BUSBAR SIDE OF HIGH-TENSION OIL SWITCHES

danger are shown in the accompanying illustration as made by the Delta-Star Electric Company of Chicago, Ill. This switch is designed for clamping or mounting directly on the bus, thus securing a high space factor. Attention is called to the fact that the adjustable contact and holding clamp enables the switch to be so located that a short run is secured to the oil switch terminal. Another useful feature is that in case the oil circuit breaker proves defective or develops short-circuits within itself, the trouble can be localized by opening the disconnecting switches.

The description of the "Tungar" rectifier built by the General Electric Company was erroneously headed "mercury arc rectifier" in the issue of Dec. 23, page 1258. As the text showed, rectification of the current does not depend on mercury.

Potentiometer for "Hot Spot" Temperature Measurement

For measuring the temperature of the hottest part of electrical machines where a thermo-electric couple is installed the Westinghouse Electric & Manufacturing Company has developed the potentiometer shown here for use therewith. This instrument balances the electromotive force of the couple under test against that of another couple at known temperature. This avoids all errors due to variation in leads, etc., and as all indications are on the "null" or zero reading principle, very accurate readings are obtained. The reading is given directly in degrees Centigrade. By using a dial switch, any number of thermo-couples on one machine or on several can be read at will with one potentiometer at any desired location. The potentiometer can also be employed for general testing work, such as resistance measurements in which electromotive forces of 5 milli-volts or less are to be measured; the determination of temperature in other than electrical apparatus, such as bales of cotton or tobacco in course of curing, and for determining the internal temperature of coal storage piles and similar uses.

The potentiometer shown is made in portable and switchboard types, and combines in one case all necessary parts with the exception of the thermo-couple

POTENTIOMETER FOR USE WITH THERMO-COUPLE INSTALLED IN MACHINES

circuit. The switchboard type of instrument is mounted in a metal case with black finish. In both types, the scale range is 0-150 or 0-200 deg. C.

A simple operation suffices to measure the temperature at the point where

the thermo-electric couple has been installed. The emf. of the thermo-couple is proportional to the difference in temperature between the cold couple and the hot one. The indication on the scale, however, is the actual temperature in degrees of the hot couple, as the setting of the lower pointer on the scale at the temperature of the cold couple (indicated by the mercury thermometer) mechanically adds this temperature to the potentiometer measurement. A simple method of checking the apparatus is to make a direct comparison with a standard thermometer by placing the test couple, furnished with the apparatus, in an oil bath with the standard thermometer and comparing the potentiometer readings.

Gas Protector for Manhole Work

The Gasco Protector Company of Waukegan, Ill., has developed a gas protector for use in manhole work which consists of a mask, flexible tubing, intake funnel and head straps. The outfit is made very light so as not to be burdensome or to interfere with the work of the wearer. The mask is constructed of rubber and aluminum. When put on the face, it is held in place by adjustable head strips, making an air tight fit, as the rim of the rubber mask is inflated through an air valve blown up by the mouth. The flexible rubber tubing that is connected to the inlet of the protector is also water and gas proof. This tubing is 12 ft. long and is equipped with an intake funnel. When the breathing is natural, there is no pressure of any kind connected to the equipment, pure air being drawn through the intake funnel and tubing to the mouth and nostrils and the

GAS PROTECTOR OUTFIT IN USE

vitiated air expelled through the exhaling valve in the ordinary process of respiration. The protector is put on as shown in the illustration and, it is claimed, that a man can enter any manhole, no matter how much gas is present, without feeling ill effects.

Electrically Illuminated Fireplaces

The Universal Stage Lighting Company, 240 West Fiftieth Street, New York City, has developed a line of imitation wood fire logs made in several sizes and designs, consisting of three or more logs, naturally grouped for interior fireplaces and outdoor campfires. The logs are made of a translucent material and asbestos, reinforced with metal and made hollow for the insertion of electric lamps. The bark and cut ends of the logs are artistically designed and hand painted to give the natural appearance of partially burned logs.

Large imitation wood logs with an imitation ash heap are made for old-fashioned open fireplaces. Both the wood logs and ashes are properly illuminated to give the natural effect.

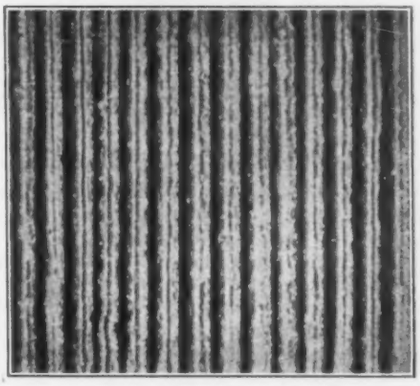
The coal fireplace designs are identical to the modern coal baskets or grates used in open fireplaces. Electric bulbs are concealed in the coal beds which consist of actual coal mixed with lumps of glass to give transparency. When illuminated this gives the appearance of a burning coal bed. To make the scene or effect more realistic

IMITATION COAL GRATE ELECTRICALLY ILLUMINATED

a chemical smoke can be used with either the wood logs or grates. Heating units are also made for use when the fire logs or grates are desired as a heater and ornament combined.

Chemically Pure Planté Positive Plate

The type of plate known as the "chemically pure" which has recently been placed on the market by the Gould Storage Battery Company, 30 East Forty-second Street, New York City, has been designed with a view toward greatly increasing the life of the positive plate and making it more nearly approximate that of the negative plate. The manufacturers state that the process of formation of the plate is entirely different from the electro-chemical processes hitherto employed in the manufacture of Gould Planté plates. The new chemically pure Planté positive was designed with a view to obtaining, if possible, the pure active material in a highly condensed form in the initial process of plate manufacture. The chemically pure active material of the new plate, with a higher capacity per square inch surface than the old electro-chemically formed plate, it is pointed out, now makes it possible to obtain normal battery capacity with a smaller plate sur-



MAGNIFIED SECTION (5 DIAMETERS) OF THE SURFACE OF THE POSITIVE PLATE

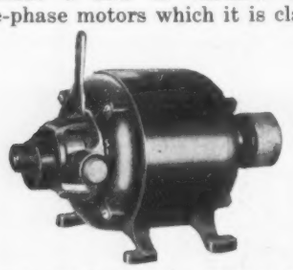
face than formerly. This permits the use of heavier ribs and wider acid space between the ribs. Where formerly the plates were made with .0020-in. ribs and .0016-in. space, the new plates are made with .0024-in. ribs and .0024-in. space, which evidently provides more reserve lead and wider space between ribs for quick and easy diffusion of electrolyte.

Attention is called to the fact that in this new construction there are apparently two distinct advantages obtained. First, there is a somewhat heavier section of reserve lead in the ribs of plate which is made for future conversion of peroxide (when there is no more reserve lead left in the ribs of the plate), the battery is about at the end of its life. Therefore, the more reserve lead provided, the longer will be the battery life. The second advantage is found in that the active material being formed in a thin but very dense skin over the surface of the ribs, the grooves between the ribs are left open clear to the bottom, permitting free circulation of electrolyte. This it is believed will remove one of the chief causes of battery sulphation, that due to highly concentrated acid becoming pocketed in the depths of the plate, as may sometimes occur where the active material is formed to such a thickness as to completely fill the space between the ribs. Moreover as the wider spacing of the new plate allows a free circulation of the electrolyte, the diffusion of the acid out of the active material on charge and into it again on discharge will be very materially assisted. Accordingly, the battery gives a somewhat higher voltage on discharge and reaches a full state of charge at a slightly lower voltage than is experienced with the older type of plate.

Another advantage of the new plate is that even if it may become badly sulphated, the active material never completely fills the space between the ribs and accordingly cannot set up expansion strains to cause buckling of the plate.

Variable Speed Motors

The R. P. Warner Electric Company of Kalamazoo, Mich., is now offering the trade a line of variable speed, single-phase motors which it is claimed

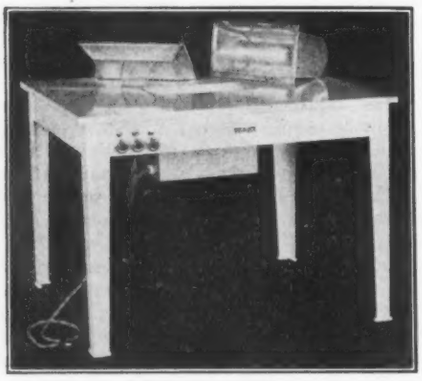


VARIABLE SPEED MOTOR THAT HAS LOW STARTING CURRENT

require no greater current for starting than an ordinary direct-current motor. The speed ranges are gradual when the rocker arm is moved back and forth. The efficiency is the same throughout the entire range of speed, because the principle used is that of varying the point of commutation, with reference to the field coils; thus getting a range from 0 to 1500 r.p.m. in some types and 0 to 4000 r.p.m. in other types. The motors are especially adapted for printing presses, ventilating fans, sewing machines, moving picture machines and running of machine lathes.

Table for Melting Chocolate Electrically

The International Electric Company of Indianapolis is manufacturing a table equipped with a heater for melting chocolate or similar material used in making candy. The table illustrated herewith consists of a ⅞-in. by 35.5-in. by 43.5-in. Italian marble top with bevelled edges mounted on a white enameled steel frame which makes the table stand 29⅞ in. high overall. In the center of the table-top is a galvanized container large enough to hold 30 lb. of chocolate. In another compartment underneath this container are located three heating elements with a total rat-

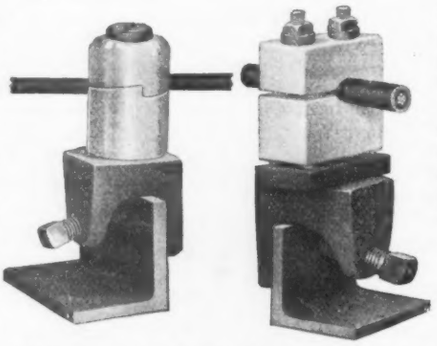


HEATER FOR MELTING CHOCOLATE OR SIMILAR MATERIAL

ing of about 300 watts. These elements are controlled by three switches on the front of the table to give high, low and medium temperatures. When the heaters are all in use, it is claimed that this device will melt about 30 lb. of chocolate in thirty minutes. The chocolate can then be maintained in its molten state by use of either the medium or the low temperature unit. The heating elements are made for any potential from 100 volts to 250 volts.

Insulator Supports

Insulator supports of malleable iron for securing insulators to open steel framework for wiring mills, foundries, shops, bridges and similar structures are now made in four sizes by the Steel City Electric Company, 1207 Columbus Avenue, Pittsburgh, Pa. These supports can be used in any position on the flanges of any standard rolled steel structural shape such as beams, angles, channels, Z bars, pipes, etc. For double-knob work a separate sup-



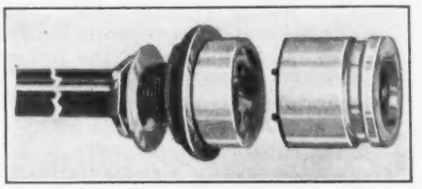
TWO TYPES OF INSULATOR SUPPORTS OF MALLEABLE IRON

port is used for each insulator. Cup-pointed case-hardened set screws are used on these supports. Where the support is subjected to constant vibration a sharp blow on the head of the set screw embeds the point in the steel and an extra turn prevents slipping or loosening.

Lighting Unit Fitting

Lighting units for shops, freight sheds, factories, etc., that consist of a combination of one-piece porcelain enameled steel reflector and a porcelain socket with lamp grip, assembled by means of a special holder, are being marketed by the Central Electric Company of Chicago, Ill. The fitting consists of a substantial malleable-iron reflector seat with a neck at the top threaded both inside and out, the inside to receive conduit and outside to receive the locknut as shown in the accompanying illustration. The reflector is held solidly between a lead washer and the locknut above and a special cork washer on top of the reflector seat below. A split porcelain socket is employed, the upper half, as shown in the figure, being fastened to the reflector seat. Two porcelain lugs are cast in the upper half of the porcelain socket and these fit into corresponding slots in the lower half of the socket and so align the two parts accurately.

Two long contact screws shown projecting above the lower half of the socket make connections both electrically and mechanically between the two parts of the socket. The lamp-base shell is so constructed as to prevent these screws from falling out and being lost when the socket is being in-



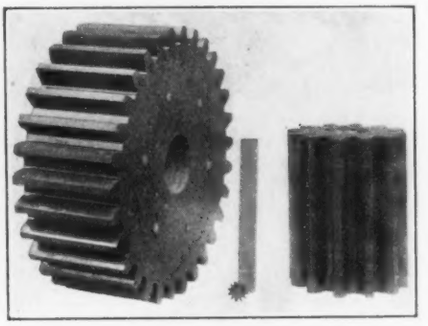
FITTING FOR USE WITH GAS-FILLED LAMPS

stalled overhead. A thin rubber gasket between the two parts of the porcelain socket makes this waterproof and where desired an additional rubber gasket at the lamp-base can be added. This protects all metal parts of the socket from both water and acid fumes such as might be experienced in roundhouses.

These fittings are made to accommodate all the standard types of reflectors up to 1000 watts. With lamps of 300-watt capacity and larger a mogul base socket is supplied.

Large Noiseless Pinions

An interesting example of what may be accomplished with Bakelite Micarta-D gear material is pointed out by the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pa., in the gears of the accompanying illustration. As will be seen by comparison with the foot rule at the right of it, the pinion in the center is 21 in. in diameter and has an 8-in. face. It is designed to transmit 100 hp. at 425 r.p.m. One of the particular features of this pinion, in addition to its large size, is the fact that no metal shroud was employed, or needed. Bakelite-Micarta-D gear material is a product of heavy duck bonded together with Bakelite by heating while under an enormous pressure, and is said to be as strong as cast iron. It is unaffected



PINIONS WITHOUT METAL SHROUD

by atmospheric changes, cannot be destroyed by rats, is vermin-proof and can be stored indefinitely without shrinking or other deterioration. It has been used for gears that operate in oil without signs of swelling.

Chronicle of Events of the Industry and of Important Movements in the Field

NEWS OF THE WEEK

Reports of Conventions and Meetings of Electrical Associations and Societies

$3,000,000 BOND ISSUE AUTHORIZED IN SEATTLE

Ordinance Passed Is Part of General Scheme for Making Enlargements of Present Municipal Light and Power Plant

As a part of a general scheme for making enlargements of the present municipal light and power plant, an ordinance was passed at a meeting of the City Council on Dec. 18 authorizing the issuance of $3,000,000 utility bonds for the purpose of purchasing a completed hydroelectric plant. The board of public works is authorized to advertise for bids for a completed plant, with a connection into the city, for the generation of 13,000 kw. of continuous energy, capable of generation of 25,000 kw. for a period of five hours each day. Authority is also lodged in the board of public works to accept any bid in its discretion complying with the general requirements outlined in the ordinance. Several weeks ago the City Council voted a condemnation of the property immediately north of the present steam auxiliary on Lake Union as a site for the construction of an additional unit to the present steam plant. Unprecedented action was taken by the Council when it followed the passage of the above ordinance with a conference with Corporation Counsel Hugh M. Caldwell, at which time he was directed to test in the Supreme Court the validity of such a bond issue made without a vote of the people.

RESTORATION OF EDISON DIFFERENTIALS A POSSIBILITY

President Edgar of the Boston Edison Company Tells Massachusetts Commission of Conferences in New York to That Effect

President C. L. Edgar of the Edison Electric Illuminating Company of Boston appeared before the Massachusetts Gas and Electric Light Commission recently as a witness in connection with the street lighting rate arbitration, being conducted by the board. He was examined at length by Corporation Counsel John A. Sullivan, on behalf of the City of Boston, relative to the license agreement with the General Electric Company and its predecessors which has been in vogue for the past thirty years. A review of the company's relations under this agreement as previously filed with the board was published in the ELECTRICAL WORLD of Dec. 23, 1916, page 1233.

Mr. Edgar said that the Boston Edison company had never paid any royalties in connection with the development of the alternating-current system. There are five Edison licensees in Massachusetts—Boston, Brockton, Fall River, New Bedford and Lowell. No municipal plants are operating in the State under Edison license, to the witness's knowledge. The Boston company has abandoned extending the Edison tube system unless to complete a street already thus equipped. At the time the Edison tube system was developed there was no underground cable in existence. The company attempted to install some underground cable in 1887, but it was a failure. License fees are not being paid on any specific item connected with the license, anything paid being based on the general patent system. Under the agreement no stock was issued to the parent company on account of the Massachusetts prohibitory law, but the proceeds of the stock sale were given the former. In other states the parent company was a proportionate stockholder for a long time and may be so to-day. As a result of a decision of the Commission (Report of 1898, pages 21 and 22), the licensee payments were transferred from capital to earnings.

The discount allowed the licensee has been gradually decreasing with the increase in the size of the competitors of the parent company and its successors and the ability of these competitors to do business. In actual practice the licensee purchased apparatus at the so-called shop cost and the parent company sold to non-licensees at an increased price. Machinery purchased by the Edison company was capitalized at the actual net price to the latter. Mr. Edgar said that the 5 per cent General Electric discount to Boston took the place of the former 3 per cent discount as the result of protests that other companies, notably in New York and Chicago, were getting the larger reduction. From the beginning there was a general understanding that the smaller companies did not get quite as liberal treatment as the big companies, because they were not buying in anything like the same quantity. The witness said he has never been interested in any of the parent organizations as a stockholder.

The percentage of royalty was cut down in recognition of the prospect of diminishing differentials between licensee and non-licensee companies. If it had not been for competition the prices to licensee and non-licensees would probably have remained in the original proportion. There was nothing in the agreement that prevented the manufacturing company from selling to a non-licensee at as low a price as to the licensee, but a non-licensee in reality could not buy directly from the manufacturing concern in the early days, the output of the latter being restricted to the parent company, the isolated company and the licensees. The non-licensee was obliged to buy from the subsidiaries of the parent company, which had to make its own profit. At the time of the consolidation forming the General Electric Company the entire outside interests probably did not sell 10 per cent of the material, but to-day probably 50 per cent of the material is sold by outside interests.

About four or five years ago as a result of governmental agitation the General Electric Company informed the licensees that it would have to discontinue the differential. The latter threatened suit, but no suit has ever been brought. Within three weeks at a conference in New York it was expected that the differential would be restored, but such action has not been taken. The next move is uncertain, stated the witness, but it will never be a large differential at Boston. No license fee has been paid by the Boston company for nearly ten years and none will be paid until some sort of final agreement is reached. The Chicago Edison company is in the same position. A number of three-party conferences have been held, but no headway has been made and no money paid. No reserve has been set aside for license fees, pending a settlement. No license has

been paid at Boston for the last $12,000,000 of capital issued. Mr. Edgar said that he thought it would be very foolish for the Boston company to break the contract. He thought a nominal payment to the licensor would be satisfactory from the Boston company's standpoint. Commissioner Schaff said that he hoped in the interest of the consumers no further license payment would be made, but Mr. Edgar said that he could not agree with this viewpoint, believing that the license agreement still has merit. "The relations between the General Electric Company and the Westinghouse company do not influence my judgment a particle in this matter," said the witness, "the question merely being one of *quid fro quo*."

MERGER OF MASSACHUSETTS UTILITY COMMISSIONS

A Single Board of Seven Members to Serve Seven Years Proposed, with Four Sub-Boards Appointed by the Chairman to Deal with the Various Utilities

Representative J. Weston Allen of Newton, Mass., has filed a bill in the House calling for the reorganization of the Public Service Commission and the Gas and Electric Light Commission. The new plan contemplates a board of seven members, to be appointed for terms of seven years, the salaries to be $7,500 each, with the exception of the chairman, who is to receive $8,000. It is contended by Representative Allen that a saving of about $30,000 a year to the state would result from the merger. According to the bill, four sub-boards of three members each are to be appointed by the chairman to deal respectively with steam railroads and steamships, electric railways, gas and electric lighting companies and telephone and telegraph service. It is proposed that each of the six members, who with the chairman constitute the board, will serve on two of the sub-boards. The chairman and secretary of the commission are to be appointed by the governor, and the chairman will have power to appoint the sub-boards and the chairman and secretary of each. A clause in the bill declares that the decision of the sub-board shall be the decision of the commission. A vigorous contest over the bill is anticipated in the present session between interests favoring conservative and radical regulative practice.

CANADIAN ENERGY EXPORTED TO THE UNITED STATES

Report to Canadian Parliament by Inland Revenue Department for Year Ended March 31, 1916, Gives Total of 1,021,780,359 Kw.-Hr.

In view of the agitation from a number of manufacturing interests that depend upon Niagara hydroelectric power for a further diversion of Niagara water owing to the limitation by the Canadian government of the amount of power that can be exported to the United States, a statement showing the quantities of electrical energy generated for export and for consumption in Canada by certain Canadian hydroelectric companies is timely. The figures shown in the accompanying table were prepared by the electrical branch of the Canadian Inland Revenue Department and were presented by Deputy Minister J. V. Vincent in his report to Parliament for the year ended March 31, 1916.

In commenting upon the export situation Mr. Vincent said:

"Under the circumstances a yearly reduction in the quantities to be exported might be deemed a reasonable method of putting an end to the export."

Of the total output, 2,250,747,089 kw.-hr. for the nine companies reporting, it will be noticed that 1,021,780,359 kw.-hr., or more than 45 per cent, was exported.

ENERGY GENERATED AND EXPORTED BY NINE CANADIAN CENTRAL STATIONS

Name of Company	Units Produced for Export, Kilowatt-Hours	Units Produced for Use in Canada, Kilowatt-Hours	Total Output of Generating Station or Other Sources, Kilowatt-Hours
Canadian Niagara Power Company	400,521,090	11,178,910	411,700,000
Electrical Development Company	34,652,000	395,346,500	429,998,500
Ontario Power Company	199,135,160	616,834,440	815,969,600
Ontario and Minnesota Power Company	13,144,070	11,789,534	24,933,604
Cedar Rapids Power Company	358,753,000	56,031,000	414,784,000
Sherbrooke Railway & Power Company	230,820	8,605,200	8,836,020
Maine & New Brunswick Power Company	3,075,893	242,437	3,318,330
Western Canada Power Company	11,937,700	60,468,020	72,405,720
British Columbia Electric Railway Company	330,626	68,470,689	68,801,315
Totals	1,021,780,359	1,228,966,730	2,250,747,089

RADIO MONOPOLY ADVOCATED

Secretary of Navy Pleads for Government Ownership of All Radio Communication as a National Safety Measure

An absolute government monopoly of radio communication as a measure of national safety was advocated Tuesday by Secretary Daniels in a letter to the commerce and marine committees of the Senate and House, outlining the Navy Department's views on the pending radio control bill drafted by an interdepartmental conference.

"The bill covers the purchase of coastal stations only, that is only those used to communicate with ships, and by permitting the Navy Department to open all of its stations to commercial business would discourage the extension of any existing commercial systems or the organization of new systems."

The Secretary wrote: "The department strongly recommends that the committee provide for the purchase of all stations used for commercial purposes. The value of existing stations is constantly increasing, and decisive action at this time will result in a saving of public funds."

In connection with Secretary Daniels's advocacy of Government monopoly of radio communication as a measure of national safety, as proposed in the pending Radio Control bill, Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, gave out a statement on Wednesday in which he said:

"The Marconi Company vigorously protests against the proposed legislation, not only because it will effectively stifle the growth of wireless telegraphy, but because it amounts practically to the confiscation of private interests.

"There are already ample laws and regulations on the statute books, giving the United States Government the necessary power for absolute control of all radio stations, in times of war or public peril. In fact, all ship and shore stations are now, and have been since 1912, operated under the control and supervision of the Department of Commerce of the United States Government.

"In time of emergency, the Marconi Company has repeatedly offered to place at the disposal of the nation not only all its operators, but the equipment of the company, and the services of the entire staff.

"Mr. Marconi is an alien, and the bill undertakes to shut out 'any company of which any officer or more than one-third of the directors are aliens, or of which more than one-third of the capital stock is owned or controlled by aliens.' All that Mr. Marconi has received for his great invention, which has been the means of saving thousands of lives, is a stock interest in the American Company, and were this bill to become law, the Government would prevent him from continuing as an officer in the management of his own company, and deprive him, as a shareholder, of his just reward. Another result of it would be to deprive this country of the benefit of Mr. Marconi's future inventions."

RECORD COPPER PRODUCTION

Output Increased About 40 Per Cent and Value Increased 100 Per Cent During 1916

The production of copper in the United States in 1916 surpassed all previous records, according to the United States Geological Survey Department of the Interior. At an average price of about 27 cents a pound the output has a value of $520,000,000, compared with $242,900,000 for the output for 1915 and with $189,790,000 in 1913.

According to the statistics and estimates received the output of blister and Lake copper from domestic ores was 1,928,000,000 lb. in 1916, against 1,388,000,000 lb. in 1915 and 1,224,000,000 lb. in 1913. The output of refined copper (electrolytic, Lake, casting and pig) from primary sources, domestic and foreign, for 1916, is estimated at 2,311,000,000 lb., compared with 1,634,000,000 lb. in 1915 and with 1,615,000,000 lb. in 1913.

The production of copper from the mines of the United States for 1916 was more than double that of ten years ago and more than four times that of twenty years ago.

NIAGARA POWER SITUATION

Niagara Falls Power Company Plans to Rebuild System and Double Output as Soon as Diversion Question Is Permanently Settled

Although the Senate on Dec. 20 passed a resolution providing for further diversion of 4400 cubic feet of water per second at Niagara Falls, the House of Representatives has not yet acted on the resolution. The measure will come up shortly and will without doubt be passed.

A permanent federal tax on power taken from the Niagara river will be a feature of a Niagara power bill which will be reported by the foreign affairs committee of the House this month, according to Chairman H. D. Flood of the foreign affairs committee. "Niagara power is the cheapest power in the world," said Chairman Flood, "and the Niagara power companies should be required to pay more for it than they are paying now. The bill will be reported about the middle of January."

Members of the Niagara Falls delegation who were in Washington urging the passage of legislation authorizing the additional diversion of water to offset large blocks of power formerly imported from Canadian Niagara companies but upon which the Ontario Hydro-Electric Commission has placed an embargo, have returned somewhat disappointed by the prospects of having a federal tax imposed upon all water taken from the river for power development. There is every indication that there will be vigorous opposition to any federal tax joker being included in the power bill.

Not satisfied with the federal tax joker, other members of Congress have hurled a broadside at several American power companies, charging them with being responsible for the serious power shortage now being experienced throughout the American Niagara frontier district. Representative Charles Bennett Smith, although advocating increased diversion until permanent legislatio ncan be agreed upon, resents asperations cast upon the federal government for failure to anticipate rapidly increasing demands for power along the Niagara frontier.

"The Niagara Falls Power Company has been more responsible than any other influence for the existing embarrassment. Its power plant and equipment is obsolete. By reconstruction it could get 100,000 additional horsepower from the water it is now diverting from the river. That would be sufficient to meet this emergency," said Representative Smith.

Replying to these assertions of Representative Smith and other members of Congress, is the announcement that plans and specifications have been completed by the Niagara Falls Power Company for rebuilding and extending its plant, involving an expenditure of more than $11,000,000. Many of the company's plans are awaiting the enactment of permanent Niagara power legislation before being carried into execution. When the plans now under consideration are carried into execution, the Niagara Falls Power Company, instead of generating 90,000 hp., will be able to develop upward of 180,000 hp. The capacity of its plant will be more than doubled. Additional transmission lines will be constructed between Niagara Falls and Buffalo and other western New York cities and towns and some of its lines will be extended into central New York and Pennsylvania.

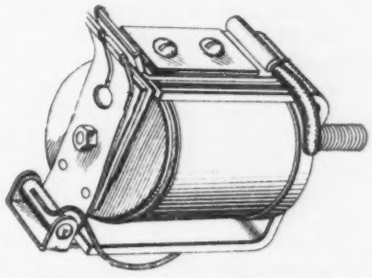
Commission Orders Contracts Filed

The Massachusetts Gas and Electric Light Commission has ordered the sixty-seven electric lighting and the fifty gas companies under its jurisdiction to file with the board before Jan. 15, copies of all contracts in force with any engineering or management corporation.

REVERSE CURRENT RELAY

By Means of Flat Spring of Non-Magnetic Material "Freezing" of Armature Is Prevented

A reverse current relay for automobile work which is "non-freezing" has been made the subject of patent No. 1,206,699 by Charles E. Harthan, of Lynn, Mass. After the engine has been started electrically and attained its



REVERSE CURRENT RELAY FOR STORAGE BATTERY WORK

normal speed the dynamo may be driven by the engine and run as a generator to charge the storage battery. In systems of this description it is desirable that the generator should be connected to the battery only when its voltage exceeds that of the battery. Heretofore this desired result has not always been attained, due to the fact that the armature of the controlling relay when

once attached is very apt to "freeze" on the once magnetized core and thereby not be enabled to perform its proper function of opening the circuit when the voltage is diminished below the critical value. A flat spring of non-magnetic material is fastened to the armature to normally hold the latter away from the magnet and keep the two contact members separated. This spring bears upon the end of the magnetic yoke and thus serves as a non-magnetic spacer between the armature and the yoke, thereby preventing "freezing" of the armature when it is attracted by the magnet.

PRIVATE OWNERSHIP SAFER AND MORE EFFICIENT

B. E. Sunny Scores Government, State and Municipal Control of Public Utility Properties and Operation

Public utilities in the hands of private owners and stockholders spread over a wide area are, according to B. E. Sunny, president of the Chicago Telephone company, safer, sounder, and more efficient than if they were in the hands of the federal government, the state, or the municipality.

Government ownership of railways has proved itself a failure in the conduct of the postoffice, said the speaker. He cited the pork barrel methods of the congressmen, and told of various legislative abuses.

"Think of the grand chain of railway stations the country might have if the railways were run by the government," said Mr. Sunny.

"One of the worst results of the campaign against the corporations," he said, "was the putting of the government into commerce. Through its most recent marine legislation the government has killed, practically, international shipping, the parcels post has ruined the express business, and now the government is building its own railway in Alaska."

UNION ELECTRIC LIGHT & POWER PROPERTY VALUATIONS

Company Submits Total of $32,586,362—Missouri Commission Experts Place Value at $22,757,409, Disallowing Many Charges

The Union Electric Light & Power Company, in a return made to the Missouri Public Service Commission, at Jefferson City, on Monday, values its plant at $32,586,362. This sum it places as the cost of reproduction Dec. 31, 1916, and it estimates the plant to be of the same value to the company. The original cost it places at $23,914,149.

Following are some of the main items in the report of the company: Cost of reproduction, $32,586,362; going value, $4,500,000; overhead charges, $3,762,940; working capital, $1,200,000; overhead system, $2,312,857; underground system, $4,156,484; original capital, $23,914,149.88; charter stock, $14,000,000.

For some fifteen months the experts of the commission have been making a valuation of this property. They completed their report this week.

The valuation of the plant and operating valuation fixed by the experts as a basis for rate making as filed with the commission, is about 30 per cent or $10,000,000 less than the value sworn to by officials of the company. The state experts say the property is worth only $22,757,409. The commission's valuation does not allow items of $5,833,102 charged to working capital, organization expenses and promotion charges.

Public Service Commission News

Idaho Commission

After investigation of the complaint that the service of the Meadows Light & Power Company was inadequate, especially during the periods of low water and extreme cold weather the Public Utilities Commission ordered the company to lay before the commission within thirty days a plan for an extension or enlargement of its present plant, sufficient to furnish electrical services to meet present demands and reasonable demands in the future. In making this decision the commission said in part:

"It is absolutely necessary that the defendant enlarge and extend its present plant and better its service to protect the investment it already has in the plant. The commission believes that if the present plant is enlarged or extended so as to give good service, the revenues will be sufficient to render a reasonable return upon the total value of the improved plant.

"On the other hand we do not mean to say that, after the defendant makes the necessary extensions, the officers can sit idly by and wait for the business to come to the company. What we mean to say is that the field is sufficiently large and the demand for electrical energy sufficiently great, under reasonable rates, to warrant such an expenditure, but the company must make an honest effort to develop the field, and the officers must by their conduct gain the confidence of the public, rather than act in an arbitrary and overbearing manner."

Alabama Commission

The Birmingham Railway, Light & Power Company will be permitted to make a general reduction of 5 per cent in its rates for electricity in Birmingham, but will not be permitted to change the rules under which it will operate in that city, it was decided by the Public Service Commission.

The lighting company presented the schedule carrying the reductions with several new rules which it proposed to put into use. These proposed changes in the rules were opposed on the ground that they would operate against the interests of Birmingham. One rule, which the company sought to invoke, provides that the company cannot be forced to supply electricity to any person living more than 150 ft. from its wire unless the person constructs a transmission line for the distance at his own expense. At present the company is forced to bear the expense of laying the lines. Through the decision of the Public Service Commission the reduction in lighting rates will become effective without the granting of any concessions by the consuming public.

Colorado Commission

Exclusive and original jurisdiction in all cases involving rate making and service of public utilities rests solely with the Public Utilities Commission under a decision of the State Supreme Court, which denied a rehearing in the case brought by the Denver & South Platte Railroad against the town of Englewood.

The Supreme Court ruled the lower court had no jurisdiction where the question of a contract between a city and a public utility corporation was involved. The railway company contracted to supply transfers to a Denver line. Later it repudiated this contract. When Englewood went into court to force the company to give transfers the utility commission intervened, claiming the courts had no jurisdiction. The high court upheld the commission's contention. It also ruled that the utilities board has the right to set aside contracts entered into between a municipality and a public utility corporation.

Largest Pelton Wheel in England.—What the London *Electrical Times* reports to be the largest Pelton water wheel constructed in England has been built by James Gordon & Company, British manufacturers, for the Kinlochleven station of the British Aluminum Company The machine has a speed of 300 r.p.m., and is rated at 3000 to 3500 b.hp.

Silvanus P. Thompson Memorial.—A fund is being raised in England to purchase the very valuable scientific library of the late Dr. Silvanus Thompson, who died June 13 last, and to present it to the British Institution of Electrical Engineers as a memorial of his life and work, the library to be accessible to the public on the same conditions as the Ronalds library.

Los Angeles $12,000,000 Bond Issue Feb. 2.—On Feb. 2 citizens of Los Angeles will vote on the question of issuing $12,000,000 in bonds with which to acquire the distributing systems of the Pacific Light & Power Corporation and of the Southern California Edison Company. Vote will also be taken at this election on a charter amendment which must be passed before these purchases could be legally made.

Heavy Increase in Quicksilver Production.—The domestic output of quicksilver in 1916, according to preliminary estimates of the United States Geological Survey, was 28,942 flasks, valued, at the estimated San Francisco average price of $125.90 a flask, at $3,643,800. This was the greatest output in quantity since 1904 and not only the greatest in value since 1875, but, excepting the value of $4,228,538 for that year, was the greatest in the history of the industry, which dates back to 1850. The figures for 1916 show an increase over 1915 of 38 per cent in quantity and 99 per cent in value.

Massachusetts Water Supply Report.—A report of the United States Geological Survey (Water Supply Paper No. 15) by C. H. Pierce and H. J. Dean, engineers, covering surface waters in Massachusetts, has recently been issued. The volume contains much data of interest from the hydroelectric standpoint and consists of 430 pages of text and tables, with eighteen illustrations. It sets forth the results of an exhaustive investigation of stream flow conditions in Massachusetts with a compilation of the available records for many years in the basins of the Hoosatonic, Connecticut, Millers, Deerfield, Chicopee, Westfield and Merrimac rivers. The report contains an introduction by N. C. Grover outlining the uses and development of water resources in the State, an article on Massachusetts topography, and a valuable gazetteer of streams and ponds, with convenient tables for the conversion of discharges into run-off depth and gallons, velocities into miles per hour, and second-feet into theoretical horsepower per foot of fall. A valuable contour map drawn to a scale of 1 in. to 4 miles shows the principal drainage basins and gaging stations. Long-term records of the flow of the Merrimac River at Lowell are a notable feature of the report.

Current News and Notes

Timely items on electrical happenings throughout the world, together with brief notes of general interest.

Topeka May Close Municipal Plant.—W. G. Tandy, one of the commissioners of Topeka, Kan., who is in charge of streets, has proposed that the city make a contract with the Topeka Edison Company whereby the company will provide the energy for the street lighting system in lieu of the proportion of earnings of the company, $4,000 to $5,000 a year, which it is claimed the company is to pay. Under this arrangement, the city would discontinue its municipal light plant which serves only the street lights, and would not make necessary expenditures for additions and improvements.

New Million Dollar Plant for Arizona Power Company.—Announcement is made by the Arizona Power Company that it has awarded the contract for the construction of an additional electric power station which will cost approximately $1,000,000. The proposed plant will be operated by steam and will have a capacity of 10,000 hp. This electrical energy will supplement that which the company is already obtaining from its hydroelectric plants at Fossil Creek on the lower Verde River. It is stated that the transmission systems of the two plants will be connected and that when the additional power of the new station is available, a transmission line will be constructed to Jerome for the purpose of providing power for operating the machinery of the local mines and ore mills.

Sanitary District May Not Get Additional Joliet Water Power.—A decision handed down by the Supreme Court of Illinois, Dec. 21, places an obstruction in the path of the Sanitary District of Chicago in its endeavor to obtain control of a dam and power site at Jackson Street, Joliet, Ill. It will be remembered that on July 17 of this year Governor Dunne of Illinois decided to lease this site, which for sixty years has been held by the Economy Light & Power Company, to the Sanitary District of Chicago (see ELECTRICAL WORLD, Aug. 5, 1915). But as soon as this decision was made a suit was begun to restrain the district from signing the contract. In the Circuit Court the injunction was denied, but the Supreme Court overruled that decision and remanded the case with directions for a verdict in conformity with its findings. The basis of the decision was a ruling that the bill which established the Sanitary District expressly states that it shall confine its operations in the manufacture and sale of electricity within a prescribed territory. The Economy site lies just beyond the limits of this territory. It is now understood that the Sanitary District will go before the Legislature in an endeavor to have its grant extended so that its territory will include the power site.

Los Angeles Appropriates Street Lighting Load.—The Los Angeles Gas & Electric Company was recently notified by the Board of Public Works of that city to discontinue street lighting service in the Highland Park and Garvanza districts north of Avenue Fifty. Beginning Dec. 20 these districts were to be supplied by electrical energy furnished under contract to Los Angeles by the municipal power plant at Pasadena. The power bureau has installed about 225 street lights in the districts on the east side of Los Angeles.

Two Years Before Cleveland Municipal Plant Can Extend Service Into New Districts.—Light Commissioner Davis has explained that surveys of the city are now being made to see where the municipal plant will secure the most patronage when it is in position to extend its service into new districts. When this is completed, the Council will be asked to decide which will be the first districts to receive the service. However, he estimates that it will be almost two years before any new districts can be served. Delivery on a new generator just ordered could not be promised under thirteen months. About six months would be required to install the generator and an additional boiler and get them into operation. The capacity then will probably take care of those only who have had applications on file for months.

Record Output of Lead.—The United States Geological Survey has just published the new year estimate of the production of lead in 1916. In the production of lead ore there was a gain of 10 per cent over the preceding year, the lead content of ore mined in 1916 being estimated at 622,000 short tons. Missouri had the largest production and also made a gain of over 25,000 tons. Good gains were made by California, Idaho, Nevada, Utah and New Mexico. The production of refined lead, desilverized and soft, from domestic and foreign ores, was approximately 579,600 tons, worth at the average New York price $73,826,000, as against 550,055 tons, worth $51,705,000 in 1915. The output of antimonial lead was about 21,800 tons. worth about $4,283,000. The domestic production was made up of 324,000 tons of desilverized lead and 234,200 tons of soft lead, worth in all about $75,915,000, and the production from foreign ores is estimated at 21,400 tons. The imports of lead in all forms were about 35,800 tons, and the exports were about 117,550 tons, of which 108,200 tons were derived from domestic ores. The total exports of lead were valued at about $15,832,000. The consumption of lead, as near as it can be calculated, disregarding stocks of domestic lead, was 471,200 tons, as against 426,751 tons in 1915. The price of lead was nearly 50 per cent higher in 1916 than during the preceding year, the average of spot quotations at New York being 6.8 cents a pound, as compared with 4.7 cents in 1915.

Institute of Radio Engineers.—A meeting of the Institute was held on Jan. 3 in New York City, when a paper on "United States Radio Development," by Robert H. Marriott, was presented.

Rochester Engineering Society.—At the next meeting of the society, to be held on Jan. 12, David L. Lindquist, chief engineer, Otis Elevator Company, will speak on "Modern Electric Elevators and Elevator Design."

Dallas Electric Club and Jovian League.—At the weekly meeting, on Dec. 22, a three-reel film, "The King of the Rails," a moving picture of the development of locomotives, was shown. These films showed construction and operating features of the Chicago, Milwaukee & St. Paul Railway electrification.

New Applications of X-Ray.—At the 180th meeting of the Schenectady Section of the A. I. E. E. held on Jan. 4, 1917, Dr. W. P. Davey and Dr. A. W. Hull of the research laboratory of the General Electric Company addressed the meeting on "New Applications of X-Rays" and "X-Rays—A Key to the Structure of Matter."

Date of Indiana New Business Meeting Changed.—The new business committee of the Indiana Electric Light Association, of which O. M. Booher of Kokomo, is chairman, will hold the first of its two 1917 conventions at Muncie, Ind., on Jan. 23. At this meeting plans for the 1917 state-wide range campaign will be discussed.

Washington Electrical Contractors.—As the result of a recent conference the electrical contractors in Central Washington will abide by the working agreements of the Eastern Division of the Washington Association of Electrical Contractors and Dealers. The association has for its aim the protection of contractors and their customers in business deals. Owing to different working conditions in the eastern and western parts of the State, it is divided into two sections. One of the agreements made at the meeting was that all bids on electrical jobs should be based on set specifications, in the absence of which time and materials should be the basis.

New York Electrical League Holds Annual Meeting.—The annual meeting of the New York Electrical League was held Wednesday, Jan. 3, at Stewart's restaurant, New York. There were 125 members present. James M. Wakeman, Jovian Statesman-at-Large, presided. The reports of the committees were read and approved, and the election of officers for the ensuing year resulted as follows: President, Arthur Williams; treasurer, A. F. De Veau; secretary, H. E. Cleland; board of directors, James M. Wakeman, James R. Pollock, George Williams and Fred Hartman. An amendment was presented to be discussed at the next regular meeting suggesting that the constitution be changed so as to provide for a vice-president and two more directors. Past-Jupiter Frank Watts addressed the meeting, giving a sketch of Jovianism from its inception and dwelling upon the necessity for well-organized local leagues, working in co-operation with the national Jovian Order.

Associations and Societies

The Directory of Electrical Associations, which is regularly printed in the first issue of each month, appears on page 63 of this number.

Pittsburgh Meeting, A. I. E. E.—The 328th meeting of the institute will be held at the Fort Pitt Hotel, Jan. 12, under the auspices of the Pittsburgh section of the traction and transportation committee. The morning and afternoon will be devoted to various committee meetings, to a number of inspection trips to points of electrical interest, and to the board of directors meeting. At 6.30 p. m. an informal dinner will be served. The technical session will be held at 8 p. m., the general subject of the meeting being "Regenerative Braking." A paper entitled "Regenerative Braking of Electric Vehicles" will be presented by R. E. Hellmund of the Westinghouse Electric & Manufacturing Company. Technical trips will be made to the following: Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.; Duquesne Light Company, Brunot's Island power plant; Pittsburgh Railways Company, Homewood shops; Pittsburgh Railways Company, Taggart Street Substation; Bell Telephone Company, Grant exchange. The Pittsburgh Railways Company will furnish special cars for the trips to its plants.

The Electrical Man's Responsibility to His Country.—H. M. Byllesby addresserd the Electric Club-Jovian League of Chicago, at its weekly luncheon Dec. 28, at the Hotel Sherman, on the above subject. In the course of his address on preparedness, he said: "If the perils to our country, now so ominously emerging, are overcome it will be because we citizens calmly and with spiritual uplift immediately consecrate ourselves to that service to the state which each of us is best able to discharge. In this rising to the defense of our beloved country, which has showered so many opportunities upon us, the electrical man must be, and naturally will be, a factor of the first importance. The electrical man has had an experience of unique value which he can place at the disposal of his country. Modern defense against aggression, and modern war itself, resembles previous periods and conditions only in the fundamentals of devotion and inflexible resolve, of physical fitness and heroism; in all other details it has become a matter of headwork, of the closest kind of mental concentration, and application of engineering, and largely electrical engineering—a matter of resource and adaptation of means to an end. The electrical man, imbued with the inspiration of his great achievements and the inspiration he has inherited from the great founders and leaders of the industry, is peculiarly prepared for his share in the defense of his country."

Winter Meeting Western New England Electrical Inspectors.—There will be held at the City Hall, Northampton, Mass., on Jan. 10, the winter meeting of the Western New England section of the National Association of Electrical Inspectors. The open session will start at 11 a. m. A. W. Hopkins, presiding. Mayor A. J. Morse will deliver the address of welcome, to which response will be made by Past National President Thomas Henry Day. Following there will be an open forum at which the subject, "The National Electrical Safety Code" will be discussed from the following angles:

What was the need for such a code? Is a single safety code to be preferred to many in various jurisdictions? Was the U. S. Bureau of Standards the proper body to take the initiative and responsibility in preparing such a code? What are the principles of protection involved? Are they sound? Do the rules of the code represent present practice? Are they reasonable? Will the application of the code promote or retard the use of electricity? How can the code be introduced into use most helpfully?

This subject, together with questions presented during the forum, will be discussed by W. J. Canada, U. S. Bureau of Standards, Department of Commerce, Washington, D. C. E. A. Braddell, of the Sprague Electric Works, New York City, will preside during the forum.

An exhibit of the methods used by several inspection departments for keeping their inspection records will be in charge of Richard J. Forsyth.

At the afternoon session, with Vice-president L. N. Heebner in the chair, there will be another open forum. This one on "The Grounding of Alternating-Current: Secondary Distribution Systems." There will be considered the following:

Its purpose and object? Does it reduce the fire hazard? Does it safeguard the life hazard? Does it injure water piping? Under normal conditions is there a flow of current along water mains thus making possible accidents to men repairing water pipes in ditches and elsewhere? What is the best method of maintaining an efficient and a permanent ground?

This subject will be explained and the above questions, and a score of others like them, will be answered by William H. Blood, Jr. of Boston, Mass., insurance expert of the National Electric Light Association and chairman of the grounding committee, National Electrical Code. W. K. Tuohey, Springfield, Mass., first vice-president National Electrical Contractors' Association, will preside during this forum. The spring meeting will occur on April 11, in Holyoke, Mass. At this meeting the changes which will have been made in the National Electrical Code will be considered. Any one desiring an invitation to attend this meeting will kindly send his name and address to the secretary, Richard J. Forsyth, 247 Wells Street, Greenfield, Mass.

REVIEW OF TRADE AND MARKET CONDITIONS

News of the Trade for the Manufacturer, Wholesaler and Jobber of Electrical Equipment and Supplies—Notes on Industrial Activities and Business Methods

INDUSTRIAL ACTIVITY DURING PAST YEAR TREMENDOUS

Production of Electrical Goods Passes the $500,000,000 Mark—Unfilled Orders Amount in Value to an Additional $200,000,000

At no time in the history of the world has industry been carried on so tremendously as during the twelve months of the year that has just passed. The new year is ushered in to the music of a record of production difficult not only to surpass but even to equal. In this flood of business prosperity the electrical industry was swept along with the leaders. Electrical manufacturers and jobbers have produced and sold to the last ounce that was physically possible, and yet the market is unsatisfied. The production of electrical goods in 1916 went beyond the $500,000,000 mark, while the unfilled orders at the beginning of 1917 were probably well over $200,000,000. There was placed, therefore, in 1916 a volume of orders for electrical equipment of $750,000,000, a most stupendous total for an industry that has practically grown up within the present generation.

Along with the immense volume of business went all of the customary features that accompany the economic condition when demand exceeds supply and also many others that were entirely new. Problems arose daily the solution to which could not be found in the pages of experience and on which decisions had to be made quickly.

A Seller's Market

Here was a clear-cut case of a seller's market, and it came on the heels of just as clear-cut a case of a buyer's market. It came so suddenly and gained momentum with such rapidity that the majority of electrical manufacturers were unprepared. Stocks were soon depleted and manufacturing facilities at the beginning of 1916 were generally insufficient. A large amount of factory space that ordinarily was devoted to the manufacture of electrical products had a few months previous been turned over to the manufacture of war munitions. When manufacturers tried to enlarge their equipment they were faced by a machinery market already flooded with orders. But little provision had been made generally by electrical manufacturers toward securing a large stock of raw materials until they were suddenly faced with a condition of practically empty bins and then the spot supply had been contracted for.

Prices naturally advanced. Raw materials were soaring rapidly and other production costs as well and manufacturers were forced to make frequent advances in price in order to insure a profit.

Here are shown some of the raw-material prices that prevailed at the beginning and ending of 1916. No attempt is made to show how high prices went in 1916.

	Dec. 28, 1915 Selling Prices Bid	Asked	Dec. 26, 1916 Selling Prices Bid	Asked
Copper, Prime Lake	21.75	to 22.00	31.00	to 31.50
Copper, electrolytic	21.75	to 22.00	31.00	to 32.00
Copper, casting	20.87½	to 21.12½	29.50	to 30.00
Copper wire base	22.75	to 23.25	37.00	to 38.00
Lead	5.40		7.50	
Nickel	45.00	to 50.00	50.00	
Sheet zinc, f.o.b. smelter	22.00		21.00	
Spelter, spot	17.42½	to 17.67½	9.80	to 10.00
Tin, straits	39.12½		40.62½	
Aluminum, 98 to 99 per cent	53.00	to 55.00	60.00	to 64.00

And although the prices were higher, the profit made by electrical manufacturers in 1916 while larger in gross amount than in previous years due to the increased volume of business was in actual per cent less than in 1915. Greater prices could have been had for the buyer was prepared to pay almost any price within reason; but the distributers of electrical goods had the best interests of the industry in mind and made every effort to keep prices down.

Labor Conditions

Labor was a particularly difficult problem to handle in 1916 and is to-day. Not counting bonuses, it is estimated that wages advanced during the year over 25 per cent. At the same time it was particularly hard to obtain sufficient and efficient labor. Offers of higher wages enticed men from shops all the time, and as a result the men always going to new jobs were grossly efficient. Labor had advanced to such an extent in prices and was so inefficient, it was estimated by the ELECTRICAL WORLD, that only about 60 per cent as much actual labor could be had for $1 in 1916 as in 1915.

In addition to the insufficiency of labor there was a scarcity of raw products. The war curtailed and in some cases stopped the supply of many products for which electrical manufacturers of this country had depended on the rest of the world: Dyes, chemicals, rubber, certain glassware, etc., and at the same time took for munition manufacture a very large portion of the raw products having origin in the United States.

Such was the condition of the labor and raw materials market that had to be faced by the electrical manufacturers in 1916, and yet, under these conditions the output of electrical products exceeded by millions of dollars that of any previous year. Demand for motors began in the fall of 1915 and was the first to feel the upward swing of business. Stocks were quickly depleted, and by the first of 1916 it was impossible to secure quick delivery except on orders for standard sizes in lots of one and two. Larger orders had to wait their turn, and deliveries were promised from six weeks to six months and ofttimes longer, depending on the size of the order and the type of motor desired. It was practically impossible to supply the demand for fractional horsepower motors. In fact, some manufacturers of small motor-driven equipment had to take their products off the market because of their inability to secure fractional horsepower motors. A case is brought to mind where a washing-machine manufacturer had a sufficient supply of washing machines in stock to supply all customers but could not fill an order for months because he could not secure the motors.

Steam and Water Turbine Production

Production of turbines, both steam and water, was very large, especially the former, of which the 1916 output was about 3,000,000 kw. The output of the latter, it is conservatively estimated, was 500,000 hp.

Owing to the sales of such a large amount of power-consuming equipment and also as a protection against the future the volume of generator buying also was large.

Wire and cable mills for the past year, excepting periods during which the men were out on a strike, have been working to capacity limit and yet local stocks are practically gone. In some sizes of stranded wire there is practically no stock in the country. Magnet wire is so scarce that motor users have been warned to use the greatest care with motors there being no stock with which to effect repairs.

Lamp manufacturers started the year with practically a three months' reserve stock on hand; but this is now about gone, and orders are now being filled from daily production with demand in excess of supply. Electric range manufacturers started the year expecting a $1,000,000 demand and soon found that the 1916 output would exceed $2,000,000 in value.

Hot, sultry weather in July and August, with no rain for

weeks in the Middle West, brought about a record demand for fans. Large stocks had been carried over by the trade from 1915, but these plus what the manufacturers had produced for the 1916 season were insufficient. So great was the demand for glassware that the mills, contrary to a well-established custom, did not shut down in the summer months.

Orders were piling up on the books at such a rate that it became useless to attempt to obtain more business, and toward the latter part of the summer salesmen began to be called in. They were kept at work, many of them, explaining to customers why goods ordered for August or September delivery probably would be received by the first of 1917, or perhaps later. New business was discouraged.

With one or two exceptions the orders placed in 1916 were not particularly large. In the first few days of 1916 a $1,000,000 order was placed for the electrical equipment of a steel mill, and in the last few weeks of the year a prominent holding company placed a $1,000,000 contract for electrical equipment for its various plants. As a rule, however, the orders were not of a size to create comment.

On the other hand, there was a marked tendency toward the purchase of units larger than ordinary rating. Orders were received for a number of 15,000-hp., 12,000-hp. and 8000-hp. motors. The 15,000-hp. size is the largest ever built. Turbo generator sets passed the 60,000 hp. mark early in the year, when a 73,000-hp. set was ordered. There have been other orders for sets in the neighborhood of 50,000 hp., which rating was unattained until a few months previous to the placing of the order for the 73,000 hp. set.

As a year of broken promises 1916 will long be remembered. Deliveries promised for four months might be delivered in eight. Nor was it altogether due to conditions over which the manufacturer had any control. First, the manufacturer had difficulty in getting machinery, help and raw materials. His deliveries were delayed and to that extent his orders were held back. In the spring, railroad lines became congested and roads had to place embargoes on practically everything except foodstuffs and fuel. Strikes were numerous, lasting generally over a month. Deliveries, therefore, grew worse as the orders piled up. As this condition became apparent to the trade, buyers began to withdraw from the market, and late in the summer a decided sloping off on incoming orders began to be noticed. Since then deliveries have been slowly getting better until at the end of 1916 they were again normal in many lines.

This condition of delayed deliveries occasioned the use of a number of new business methods each with its own problem. To save time, raw materials in small lots were ordered shipped express, thereby increasing transportation charges, and when deliveries of the finished product were delayed the buyer received his goods by express. There arose, therefore, the question of who should pay the excess charges of express cost over freight, shipper or receiver. Materials and goods were ordered by telephone that formerly were ordered from a salesman or by letter.

Previous to this past year a number of foundries were engaged in manufacturing electrical products such as lamp-posts, boilers, condensers, steam and water turbines, etc. Many of these foundries during 1916 discontinued the manufacture of all electrical products. These were taken up originally as a side line, and as soon as regular work was great enough to take up the entire foundry space the side lines were abandoned.

Few New Products Developed

Few new electrical products were developed during 1916. Probably about half as many new wiring devices were placed on the market in 1916 as in 1915. Manufacturers were too busy during the past year to devote the time or necessary factory space to the development of new products. Furthermore, it was with great difficulty that raw and manufacturing materials could be had in quantities sufficient for the manufacture of products then on the market. Instances are recalled where the sale of new products brought out during the year was not pushed because of the impossibility of obtaining the necessary manufacturing materials.

Credit conditions in 1916 were excellent. Credit terms were generally tighter than had been the rule. This was made possible by the excess of demand for electrical goods over the supply. Trade acceptances were more generally in use by the electrical industry. Collections were excellent. A larger number of buyers took advantage of the discounts for prompt payment.

Buyers' stocks were large, particularly those of jobbers. In many instances stocks were 100 per cent greater than normal, not because of a 100 per cent increase in demand, but because of delayed deliveries. In order to protect customers larger stocks were necessary, for should stocks get low the jobbers knew that it would be months before they could be replenished. This heavy increase in stocks caused manufacturers considerable apprehension particularly as a credit risk. Where it was thought that a buyer had overstocked, particularly stringent credit terms were imposed.

Electrical Jobbing Business in 1916

The jobbing business was exceptionally large in 1916. Jobbing picked up in the fall of 1915 and has continued large since then. The 1916 jobbing business was at least 50 per cent greater than in 1915.

The more extended use of electricity in the past year brought a large demand on the jobber. Wire, conduit, fittings, fans and household appliances sold very well. Better factory lighting brought about the sale of large quantities of lighting materials, such as reflectors, lamps, shades, etc.

Jobbers' expenses have been growing steadily heavier and out of proportion to the increase in business. Owing to the large sale of small lots of electrical merchandise at wholesale prices jobbing overhead has rapidly increased. Particularly has this been true of the local jobber, and late in the year there was begun a movement towards eliminating this evil from the jobbing trade. One of the suggestions was the institution of a standard package for each article of merchandise. This package would then be the jobbing unit, no sale to be made at wholesale prices of part of a unit.

The movement to simplify discounts in the electrical trade found favorable action in 1916. This was in large part due to the existing trade conditions. Rather than raise list prices one or two of the trade discounts were lopped off when a price increase became necessary. When it became apparent that discounts were becoming simpler, a number of manufacturers took the final step and made but a single basic discount. In most cases this final discount is equal to the combined old first and second discounts.

As the year wore on the number of electrical factories under construction increased. Plans were laid for one $7,000,000 factory and many separate plants at over $1,000,000 valuation. In looking forward to the coming months of the new year this large building plan is significant, meaning, as it must, that the manufacturers have confidence in the months to come.

Also a surprisingly large number of new companies were organized during the year to engage in electrical manufacture. None of these companies, however, was particularly large.

In the second-hand market for electrical goods conditions in 1916 were without precedent. Poor deliveries and necessity for immediate shipment continued to reduce the second-hand stock, particularly of motors, from one of large dimensions to a very few pieces. Direct-current motors that had been replaced by alternating-current motors again went on the lines.

As a direct result of the May Chicago N. E. L. A. convention electric vehicle manufacturers offered under different plans special discounts to central stations on truck sales. Although the plans have been in effect but a few weeks the number of sales resulting has been quite appreciable.

There was noticed late in 1916 a tendency toward more popular prices of passenger electrics. Two well known companies put out models to sell under $2,000, while a $700 model has been announced as ready for exhibition.

The movement for standardization received in the past year a great impetus. The Electric Power Club, the Associated Manufacturers of Electrical Supplies and the Electrical Supply Jobbers' Association have all been busy in promoting standardization of different lines.

A number of important patent matters that had been hanging fire for some time were taken up and agreements made. The General Electric Company in February won its suit against the Laco-Phillips Company for infringement of the Just and Hannaman patent for a tungsten incandes-

cent lamp. Since that time a number of independent lamp manufacturers have been licensed to manufacture their lamps under the patent. Licensee arrangements were made by the General Electric Company and the Hoskins Manufacturing Company, owners of the Marsh patent for nickel chromium as a resistance element, with the several manufacturers of heating appliances. Under the terms of the license there will now be a minimum selling price for all classes of appliances. In December the Kenny patent owned by the Vacuum Cleaner Company was sustained in the portable electric class.

Based on the government returns for the first ten months of the past year the value of electric exports of American manufacture reached a new high record in 1916. Estimates made by the ELECTRICAL WORLD put the 1916 electrical exports at between $37,000,000 and $40,000,000. The year was notable in the large increase in the value of the exports of insulated wire and cables, metal filament lamps, motors and miscellaneous merchandise.

Much of the increase in exports has been to England, France and Russia to supply the markets formerly supplied by Germany.

SUPPLY JOBBERS STOCKS AT BEGINNING OF NEW YEAR

Reports from Different Sections of the Country Show Buying for 1917 to Be Regulated Generally by Both Deliveries and Demand

Electric supply jobbers are very uncertain regarding the prospects for 1917, according to reports received by the ELECTRICAL WORLD from most of the important jobbing centers of the country. Jobbers were asked to report concerning the present condition of stocks and the manner in which 1917 buying would be regulated.

The reports show that stocks are generally large, with a shortage in wire. Jobbers seem to be divided in regard to buying for 1917. Some will place large orders far in advance to offset poor deliveries, while there was also a decided tendency to be very conservative in buying. This element of jobbers are fearing a peace negotiation, when it is expected that prices will fall. A satisfactory profit has already been taken on the rising market. No desire is felt by these jobbers to sacrifice these profits in a falling market.

Following are the conditions as they exist locally:

NEW ENGLAND

Boston, Mass.—Large stock being carried at present as result of heavy volume of trade and efforts to anticipate demand. Large stock on hand of lamp cord, insulated wire, cable, conduits, lamp sockets and fittings, heating appliances, lighting fixtures and miscellaneous supplies. Fan supply low; shortage of incandescent lamps.

No special stocking up is planned, but the policy is to maintain a steady patronage of the manufacturers; purchases responsive in volume to demand anticipated. No let-up in demand apparent for next few months.

Demand will be a larger factor than deliveries as 1917 comes in. Some difficulty expected in obtaining iron conduit.

Worcester, Mass.—In the main, stock is about normal. Deliveries are good, 90 per cent of recent orders being delivered within about thirty days. Another 10 per cent advance in manufacturers' prices is hinted. More lamps could have been sold had they been obtainable. Less-than-normal supply of lamp cord; normal supplies of insulated wire, cable, lamp sockets and fittings, wiring supplies and fittings; extra supply of fans, normal supplies of fractional horse-power motors, heating appliances, lighting fixtures and miscellaneous electrical equipment.

Delayed shipments of iron conduit due to railroad congestion are causing trouble. Very small demand for fans for winter uses in Worcester; mercantile field for winter fan service pretty thoroughly filled.

The buying in 1917 will be influenced by both delivery and demand. It is hoped that improved deliveries can be had on items at present handicapped, thereby tending to reduce overhead costs necessitated by attempting to carry stock large enough to offset delays in filling orders.

ATLANTIC STATES

New York, N. Y.—Stocks are large on almost all items because jobbers anticipated poor deliveries. Buying in 1917 will be governed by both deliveries and demand, particularly the former, should the market hold up.

Philadelphia, Pa.—Stock on hand at present is worth more than usual at this time of the year, due mostly to increased value of items. Great delays experienced in getting all standard items. Buying will be for requirements, and will stop as long as possible after the slightest consideration of peace abroad. Because losses on electrical supply stocks are likely to be terrific when prices fall stocks are being kept down.

Richmond, Va.—Value of stock in excess of normal, but unbalanced, being large in some items and small in others. Stock normal in lamp cord, conduit, fans, heating appliances (short on some items) and lighting fixtures; below normal on all other standard goods, and large in miscellaneous items. Fractional horsepower motor stocks practically depleted, lamp deliveries very uncertain and unsatisfactory. Purchases for 1917 will be governed by both delivery and demand, but owing to market conditions delivery will probably be the most important factor.

CENTRAL STATES

St. Joseph, Mo.—Shortage in asbestos covered wire, rubber covered wire and transmission line material. Buying will be cautious in view of a possible slump in future prices.

Birmingham, Ala.—Present stock is large but the supply on hand of lamp cord, fans, fractional horsepower motors and lighting fixtures is small. Owing to a fear of the market breaking future buying will be light, and will be governed principally by delivery.

St. Paul, Minn.—Large stocks on hand because of poor deliveries. Provided materials can be secured 1917 stocking will be heavy. Delivery will be more important than demand in regulating 1917 buying.

Memphis, Tenn.—At the present time merchandise stock is practically normal. An effort has been made to increase the stock in anticipation of slow shipments from manufacturers, and to take advantage of the rising market by investing as much capital as possible in the purchase of goods. These efforts, however, have been largely negatived by the inability of factories to make shipment in accordance with promises. Buying in 1917 will be influenced both by delivery and demand, but more largely by the former unless some radical change occurs in conditions.

New Orleans, La.—Stock is large and will be kept so provided deliveries can be had. Long time orders are being placed.

San Antonio, Tex.—Stocks are larger and buying heavier. Stocks of insulated wire are small because of poor deliveries.

PACIFIC COAST STATES

Los Angeles, Cal.—Stock is about average. Future requirements were anticipated and stocks laid in accordingly. Stocks are small in lamp cord, insulated wire, cable, lamp sockets and fittings, wiring supplies and fittings, fans, fractional horsepower motors, incandescent lamps. This is mostly due to a shortage on the Pacific Coast. As long as the market remains in an unsettled condition stocking will be light. Buying for 1917 will be equally influenced by demand and delivery.

San Francisco, Cal.—Stock small of lamp cord, insulated wire, cable, fans (out of season), due generally to poor deliveries. Other stock is normal. Buying will be guided by demand.

Seattle, Wash.—Very small stocks of lamp cord, insulated wire and cable, lamp sockets and fittings, wiring supplies and fittings. Other stocks are generally satisfactory or large. On account of poor deliveries business is being anticipated by ordering from two to six months ahead.

Tacoma, Wash.—Stock is small in lamp cord, insulated wire and cable, but generally satisfactory or large in other items. Business in 1917 is expected to be larger than in 1916. Larger stocks will be laid in.

Manufacturing and Industrial

Stanley M. Tracy, until recently Western district manager in the Chicago office of the Driver Harris Wire Company, is now assistant general sales manager at the main office and works of the company, Harrison, N. J.

The American Lighting Company, which has been conducting a business in flood-lighting equipment, after Dec. 31, 1916, will change its name to the Davis Lighting System. Its address will continue to be 1422 West Randolph Street, Chicago.

F. H. Poss became sales manager of the Benjamin Electric Manufacturing Company on Jan. 1. He was formerly Pacific Coast manager for the same company, having opened that office in 1905. Between 1905 and 1912 he also represented the Holophane Company.

Page & Hill Company, Minneapolis, Minn., announces the addition to its sales force of Buford Adams, who will act in the capacity of sales engineer. Mr. Adams is well known, particularly through the Southwest, as a practical engineer and manager of public service properties.

Goulds Employees Get Bonus.—Each of the 900 employees of the Goulds Manufacturing Company, Seneca Falls, N. Y., on Dec. 23 received a bonus of a full month's pay. The action was taken because of the increased cost of living and as a token of appreciation of the endeavors of the members of the organization.

The American Conduit Manufacturing Company, Pittsburgh, Pa., announces that beginning Jan. 1, M. B. Austin & Company of 700 Jackson Boulevard, Chicago, Ill., will be its sales agents in Chicago for the following products of its manufacture: "Wiremold," the new surface wiring material, and "Wireduct," a non-metallic flexible conduit.

Hughes Company Insures Employees.—As a token of its appreciation of their services and to demonstrate that it is interested in the welfare of the families of its employees, the Hughes Electric Heating Company of Chicago, gave insurance policies to all workers who had been employed by the company more than ninety days. The amounts of the individual policies range from $500 for the employees who have been only a short time in the service of the company to $1,000 for those who have been employed five years or more.

Harry Pickhardt has severed his connection with the Phœnix Glass Company for which he has been assistant sales manager during the past eight years to enter business at 98 Park Place, New York City, as sales agent, handling lighting specialties, having bought out the business of L. D. Hatton, deceased. Mr. Pickhardt will handle the line of John Dunlap Company, Carnegie, Pa., manufacturers of enameled steel reflectors, and in time expects to add other lines. Mr. Pickhardt was with the Holophane Company for two years as sales engineer, and previous to that was in the electrical business in New England.

NEW YORK METAL MARKET PRICES

	Dec. 26 Selling Prices Bid	Dec. 26 Selling Prices Asked	Jan. 3 Selling Prices Bid	Jan. 3 Selling Prices Asked
	£ s d		£ s d	
London, standard spot Copper	141 10 0		133 10 0	
Prime Lake	31.00 to 31.50†		29.00	to 29.50†
Electrolytic	31.00 to 32.00†		28.00	to 29.00†
Casting	29.50 to 30.00†		27.00	to 28.00†
Copper wire base	37.00 to 38.00		36.00	to 38.00
Lead	7.50		7.50	
Nickel	50.00		50.00	
Sheet zinc, f.o.b. smelter	21.00		21.00	
Spelter, spot	9.80 to 10.00		9.67½	to 9.92½
Tin, straits	40.62½†		42.75†	
Aluminum, 98 to 99 per cent.	60.00 to 64.00†		55.00	to 58.00†

OLD METALS

Heavy copper and wire	27.00 to 27.50†	24.00	to 25.00†
Brass, heavy	15.00 to 15.50†	14.50	to 15.50†
Brass, light	10.50 to 11.00†	10.50	to 11.00†
Lead, heavy	6.50 to 6.75†	6.50	to 6.62½†
Zinc, scrap	7.50 to 8.00†	6.00	to 6.25†

COPPER EXPORTS

Total tons to Jan. 3 323

†Nominal.

LIGHT AND POWER UTILITY FINANCING DURING 1916

Analysis of Bond, Note and Stock Issues Reported Offered for Investment During the Past Twelve Months

Electric light and power companies in 1916 faced a market for investment securities that seemed bottomless, and a market for construction materials in which prices had passed all former bounds. This was exactly the opposite condition to that met with during the two previous years with the exception of the latter part of 1915.

At the outbreak of the war money became very tight and investors were unwilling to part with it except at very high prices and short time. As a result there sprung up in 1914 and 1915 a vast amount of short-term financing such as one, two and three-year notes. Because of the sale price, the high interest rate and the short life such a mode of financing was exceedingly costly.

When the investment market again opened there seemed to be no limit to the amount of securities it could absorb. Money became more plentiful and easier and better rates were offered. Security prices accordingly rose and at the same time the margin of profit for the bond merchant became less. There was such a buying competition that it cost utilities much less to market their securities.

The time was ripe, therefore, to begin long time permanent financing. Very little temporary financing was evident during the year. Of eleven note issues reported nine were new issues. The maturities of the eleven note issues were as follows: Two years, two issues; three years, five issues; five years, two issues; ten years, one issue and twenty years, one issue. Most of the issues bore interest at 6 per cent and the remainder at 5 per cent; but few were convertible. The total amount reported issued was $22,650,000 for which the average price was 99 with 100.5 high and 95 low.

The bulk of the financing was in bonds, of which there was reported from the electric light and power field for investment fifty-nine issues with a total value of $115,472,300. Of these twenty-six were new issues. Forty-two issues were first mortgage, two convertible debentures and seven general mortgages. Of fifty-six bonds the maturities were as follows: Thirty-year, twenty or 35.8 per cent; forty-year, ten or 17.9 per cent; twenty-five-year, seven or 12.5 per cent; ten-year, six or 10.7 per cent; twenty-year, five or 8.9 per cent, and the rest at odd years. Thus two-thirds of the bond issues offered to investors in 1916 would mature in twenty-five years or longer.

The average price of the bonds was 97.03 with 104.25 high and 89 low. The new bonds were sold at an average price of 98 and the old issues at an average price of 96.3, a total of 65.5 per cent of the bonds bore interest at the rate of 5 per cent, and 33.4 per cent at the rate of 6 per cent.

Nine stock issues were reported for investment totaling $14,699,500. All were cumulative preferred issues with 6 and 7 per cent dividends, more however being in the 6 per cent dividend class.

Corporate and Financial

Counties Gas & Electric Company, Norristown, Pa.—The company has received permission from the Pennsylvania Public Service Commission to acquire the outstanding stock and control of the Lansdowne Construction Company, operating electric properties at Lansdowne, Delaware County, and vicinity.

Lorain (Ohio) County Electric Company.—The Ohio Public Utilities Commission on Dec. 29 gave the Lorain County Electric Company authority to close a lease for the plant of the Citizens Gas & Electric Company for a term of twenty-five years at a total consideration of $250,000. Many improvements and extensions have been planned.

Northern Idaho & Montana Power Company, Sandpoint, Idaho.—Elmer Dover, president of the company, has been named receiver for the corporation by Judge Rudkin of the United States District Court at Spokane. It is stated that this action is preparatory to a friendly reorganization whereby the capitalization will be reduced and the company equipped with funds for the construction of immediate

and future extensions. For several years the Northern Idaho & Montana Power Company has not earned its full bond interest charges, due to the failure of the communities served in Oregon, Washington, Montana and Idaho to develop in population and industries as rapidly as was expected when the original investments were made in the physical properties. With the return of prosperity to the lumber industry and the resumption of agricultural development a considerable quantity of profitable new business may be obtained by making extensions which the company is unable to finance in its present condition. In order to best conserve the interests of security holders and to properly serve its field reorganization is deemed necessary by the management, H. M. Byllesby & Company. Northern Idaho & Montana Power Company and its subsidiary, The Oregon Power Company, operate in territories with about 50,000 population, centering at Kalispell, Mont.; Sandpoint, Idaho; Newport, Wash.; and Albany, Eugene and Marshfield, Ore.

Robbins & Myers Company, Springfield, Ohio.—The company has announced that it will increase its capital stock from $1,000,000 to $5,000,000, to take care of needed improvements and plant extensions. The company increased its capitalization from $500,000 to $1,000,000 about two years ago, but the rapid increase in its business has necessitated further capital. An issue of preferred stock amounting to $1,500,000 has been taken at $105. The company is now employing 2400 persons, and expects to increase this number to 3000 shortly.

Washington-Idaho Water, Light & Power Company, Clarkston, Idaho—An issue of $600,000 first mortgage sinking fund 6 per cent gold bonds, due May 1, 1941, is being offered at par and interest.

New Utility and Industrial Companies

The Laverne (Okla.) Light, Power & Ice Company has been chartered with a capital stock of $30,000 by W. H. K. Lewis, E. R. Lewis and M. Lewis of Laverne.

The Newton (N. J.) Electric & Gas Company has been incorporated by F. W. Hills, A. H. Atterbury and Morgan Colt. The company is capitalized at $125,000 and proposes to supply electricity and gas in Newton and vicinity.

The Huntsville (Utah) Power & Light Company has been incorporated with a capital stock of $1,000 by Joseph L. Petersen, Alma L. Petersen, O. L. Petersen and others. The company proposes to supply electricity in Ogden valley towns.

The Car Lighting Improvement Company of Milwaukee, Wis., has been incorporated by Julian Olds, John A. Dietrich and T. H. Spence. The company is capitalized at $25,000 and proposes to manufacture and sell the Watson car lighting device.

The South American Electric Smelting Company of New York, N. Y., has been incorporated with a capital stock of $50,000 to do a general mining, smelting and refining business. The incorporators are: C. W. Whittlesey, J. B. Pruyn and W. P. Martin, 17 Battery Place, New York, N. Y.

The Aurora Battery Corporation of Buffalo, N. Y., has been incorporated with a capital stock of $25,000 to manufacture primary and secondary electric batteries for automobiles. The incorporators are: H. H. Servis, L. A. Brahler and E. Linck, 364 Connecticut Avenue, Buffalo, N. Y.

The Best Electric Wire Company of Jamesville, N. Y., has been incorporated by E. C. Spencer, G. A. Cowles and A. A. Reed, 136 Cortland Avenue, Syracuse, N. Y. The company is capitalized at $250,000 and proposes to manufacture and deal in wire, wire rope, cable, conduits, etc.

The Hartland (W. Va.) Power Company has been incorporated by John B. Hart, Osman E. Swartz, E. B. Templeman, R. O. Fallon and W. G. Swathers, all of New York, N. Y. The company is capitalized at $700,000 and proposes to generate and transmit electricity for public use.

The Kellogg-Burlingame Company of Grand Rapids, Mich., has been incorporated by Robert B. Kellogg, M. V. Burlingame of Grand Rapids, and Charles J. Davis of Lansing, Mich. The company is capitalized at $10,000 and proposes to deal in pumping machinery and power plant equipment.

The Arkansas Utilities Company of Heber Springs, Ark., has been incorporated with a capital stock of $20,000 to construct and operate electric light and power plants. The officers are: Dr. A. R. Amos of Little Rock, president; R. N. Case of Heber Springs, vice-president; Guy A. Watkins of Little Rock, secretary and treasurer.

The Augustus A. West Automobile Invention Company of New York, N. Y., has been chartered with a capital stock of $50,000 to manufacture devices and to do electrical work. The incorporators are: A. A. West, 32 Ross Avenue, South Ozone; S. Nelson, 423 Fifty-seventh Street, Brooklyn, and A. J. Cahill, 544 Summit Avenue, Jersey City, N. J.

The Bailey Non-Stall Differential Corporation of Millbrook, N. Y., has been incorporated with a capital stock of $105,000 to manufacture autos, taxicabs, aeroplanes and carry on a general electrical and mechanical engineering business. The incorporators are: H. S. Perrigo, 660 St. Nicholas Avenue, New York City; F. H. Butchorn, 764 St. Johns Place, Brooklyn, N. Y., and E. A. Gingras, Englewood, N. J.

Trade Publications

Lighting Fixtures.—The Macbeth-Evans Glass Company of Pittsburgh, Pa., has issued an illustrated folder descriptive of Macbeth-Evans lighting equipment for store lighting.

Control Devices.—The Rowan Electric Manufacturing Company, Inc., of Baltimore, Md., has prepared a loose-leaf booklet on its Automatic Protective and Control Devices for Electric Motors.

Batteries.—"Automobile Starting and Lighting with the Cincinnati Battery" is the title of a bulletin recently prepared by the Cincinnati Storage Battery Company, 228 Stark Street, Cincinnati, Ohio.

Rotary Converters.—The British Thomson-Houston Company, Ltd., Rugby, England, has prepared descriptive list No. 2420-A descriptive of rotary converters. This bulletin goes into the general description of these rotary converters.

Push Sockets. — An eight-page pamphlet has been published, including descriptions and illustrations of C-H push sockets manufactured by the Cutler-Hammer Manufacturing Company of Milwaukee. This folder is of the type furnished to dealers and jobbers, carrying imprint for distribution.

Electrical Supply Year Book.—The Western Electric Company, Inc., of New York, is distributing its 1917 Year Book on electrical supplies. This 1917 Year Book follows the plan of uniform list prices that was inaugurated in the Year Book of 1915. This 1310-page volume is well illustrated and has been carefully prepared in such a manner as to make things easy to find for the prospective purchaser.

Starters.—Automatic starters for squirrel cage induction motors are described and illustrated in descriptive leaflet No. 1660 just issued by the Westinghouse Electric & Manufacturing Company. These starters are used with single-phase and polyphase squirrel cage induction motors of all commercial ratings where it is desired to start from a remote point and where automatic acceleration is necessary on account of unskilled operators. The construction details are given in full and illustrations of component parts are shown.

Push-Button Specialties.—Catalog No. 8, a new 48-page booklet describing and listing C-H push button specialties, is now being distributed by the Cutler-Hammer Manufacturing Company of Milwaukee. This revised catalog contains 138 illustrations of sockets, switches, plugs, receptacles and other wiring devices as well as fourteen diagrams of the wiring connections for the C-H automobile lighting switches. Among other new products listed and described are the C-H 6-amp. pull switches, the new C-H "Standard" plug, that has a riveted blade construction and is interchangeable with plugs and receptacles of six other manufacturers; the remote control switch; composition feed-through switch; standard attachment receptacles; and new current tap. There is a complete index of catalog numbers in this edition, making it of greater use to contractors and others requiring C-H wiring devices.

New England

AUGUSTA, ME.—The Central Maine Power Company has recently taken over the plant and distributing system of the Hartland (Me.) Electric Light & Power Company and also the system of the Newport (Me.) Light & Power Company, which will be connected with the main transmission line running through to toward Moosehead Lake. It is reported that the Central Maine Company has also purchased the controlling interest in the Skowhegan Pulp Company, which would give it 4011 hp. out of 5588 hp. of the present development of the Skowhegan company on the Kennebec River.

BRATTLEBORO, VT.—The Twin State Gas & Electric Company is planning to install an ornamental lighting system on Main Street to replace the present system of incandescent lamps strung across the street.

MILTON, VT.—The water power rights on the Lamoille River at Milton, formerly owned by H. O. Clark, have been purchased by the International Paper Company of New York, N. Y.—The new owners, it is understood, will develop the water power to generate electricity.

HUNTINGTON, MASS.—The Selectmen of Huntington, Cummington, Chesterfield and Worthington have petitioned the Legislature to pass a bill granting the Westfield River Railway Company a charter to construct an electric railway along the Westfield River and Major Brook; also to generate electricity to operate the proposed railway and to supply energy to adjacent towns for lamps, heaters and motors. The capital stock is placed at $182,000. Leonard F. Hardy of Huntington is interested.

LEOMINSTER, MASS.—The J. G. White Engineering Company, 43 Exchange Place, New York, N. Y., has been awarded a contract by the Leominster (Mass.) Electric Light & Power Company for designing and construction work in connection with the erection of a new electric transformer substation of the outdoor type, with distribution lines in Leominster.

WATERTOWN, MASS.—Plans have been completed for improvements to the power plant at the Arsenal Grounds of the United States Government at Watertown, to cost about $12,000. Monks & Johnson, 78 Devonshire Street, Boston, are engineers. M. T. Carney of Watertown is purchasing agent.

PACKER, CONN.—The stone mill at Packer, it is reported, is being considered by a Plainfield firm as a power site for an electric power plant.

Middle Atlantic

BUFFALO, N. Y.—Work will soon begin on the construction of a power plant, a 200-ton ice manufacturing plant and a machine shop for the Schoellkopf Aniline & Chemical Works, at Abbott Road and the Buffalo River. The John W. Cowper Company of Buffalo has the contract for erection of buildings and also for equipment, which includes battery of six 1000-hp. boilers for power plant; coal bunkers, coal and ash-handling machinery, stokers, air compressors, and a 200-ton ice plant and machine shop equipment.

BUFFALO, N. Y.—The Public Service Commission has granted the Niagara & Erie Power Company, of Buffalo, permission to erect additional electric generating plants and extend its transmission lines in several sections of western and southwestern New York. A 60,000-volt transmission line will be erected from the company's station in Lackawanna through towns and villages along the lake shore as far west as Dunkirk. This will involve an immediate expenditure of approximately $30,000, with an ultimate development, costing more than $150,000. A second new transmission line will be built from Fredonia to Cassadaga, at a cost of about $6,000; a power plant will also be erected in the town of Stockton.

COBLESKILL, N. Y.—Bids will be received by D. D. Frisbie, president board of trustees, Agricultural Hall, State and Lodge Streets, Albany, until Jan. 9, for construction, heating, plumbing and drainage and electric work for dairy building at Schoharie State School of Agriculture, Cobleskill. Drawings, specifications and blank forms of proposal may be obtained at the Department of Architecture, Capitol, Albany. Drawings and specifications may be consulted at the Schoharie State School of Agriculture, Cobleskill; New York office of Department of Architecture, Room 1224, Woolworth Building, and Department of Architecture, Capitol, Albany.

DUNKIRK, N. Y.—Not being able to obtain sufficient coal to keep the municipal electric plant working at its full capacity, the city authorities are considering a proposal to purchase a block of power from the Niagara & Erie Power Company, of Buffalo to enable the municipal plant to meet the increasing demands made upon it. The city has ordered an additional turbo-generator, but delivery will not be made for 18 months.

Construction

News of Projects, Plans, Bids and Contracts. Notes on Work Under Way

EDMESTON, N. Y.—The installation of an electric-lighting system in Edmeston is under consideration.

LOCKPORT, N. Y.—A committee has been appointed to make investigations relative to the installation of a municipal electric-light plant in Lockport.

NEW YORK, N. Y.—Bids will be received by Robert Adamson, fire commissioner, eleventh floor, Municipal Building, New York, N. Y., until Jan. 12 for furnishing wire and metals. Blank forms and further information may be obtained at the office of the Fire Department, Eleventh Floor, Municipal Building.

NEW YORK, N. Y.—The general contract for the construction of a 16-story telephone exchange and office building for the New Telephone Company, to be erected on Broad Street, between Pearl and Water Streets, has been awarded to the Cauldwell-Wingate Company, 381 Fourth Avenue, New York City. The cost of the building is estimated at $1,200,000.

NEW YORK, N. Y.—Bids will be received by William Williams, commissioner of water, gas and electricity, Room 2318, Municipal Building, New York, until Jan. 9 for furnishing and maintaining electric lighting units for lighting public streets, parks and places from Jan. 10 to Dec. 31, 1917, both inclusive, in the first, second, third and fourth wards of the borough of Queens. Blank forms, etc., can be obtained at Room 2324, Municipal Building.

PANAMA, N. Y.—The town of Harmony has granted the Panama Traction Company a franchise to construct and operate an electric railway between Ashville and Panama.

QUOGUE, N. Y.—Work has been started by the Suffolk Light, Heat & Power Company of Southampton on the erection of an electric transmission line to Quogue, to supply electrical service here.

ANGELICA, PA.—Plans are being prepared by W. H. Dechant & Son, Bear Building, Reading, for the reconstruction of the plant of the Angelica (Pa.) Water & Ice Company, to include filtration plant, pumping station and complete hydroelectric development of the water power rights owned by the company on Angelica Creek. Post office address, Angelica, R. F. D. from Mohnton.

DU BOIS, PA.—The City Council is considering a proposal submitted by J. E. Du Bois, owner of the local electric-light plant, offering to sell the plant to the city of Du Bois for $30,000. Under the terms of the franchise the city has the privilege of purchasing the plant at the end of the ten-year period, which will expire next August.

PHILADELPHIA, PA. — Plans have been filed by the Hutlon Printing Company for an addition to the boiler plant at its factory, on Frankford Avenue.

PHILADELPHIA, PA. — Contract has been awarded by the Philadelphia Rapid Transit Company for extensions and alterations to its Kensington power plant.

PHILADELPHIA, PA.—Extensive additions and improvements are contemplated to the building of the Philadelphia Electric Company at Tenth and Chestnut Streets, involving an expenditure of about $500,000. The plans provide for the erection of a nine-story addition adjoining the building to the west and the erection of three additional stories on the corner property. John T. Windrim is architect. The John R. Wiggins Company has been awarded contract.

SOUTH BETHLEHEM, PA.—The Third Street Business Men's Association has been organized in conjunction with property owners on Third Street and Northampton Avenue for the purpose of raising funds ($15,000) for the installation of an ornamental street-lighting system along these thoroughfares.

BAYONNE, N. J.—The City Commissioners are considering a petition presented by property owners for the installation of an electric-lighting system along upper Broadway, extending to Fortieth Street. The installation will be made by the Public Service Electric Company.

JERSEY CITY, N. J.—The City Commission is negotiating with the Public Service Electric Company for the installation of a new street-lighting system on Monticello Avenue, to be maintained by underground wires.

JERSEY CITY, N. J.—Estimates of cost for a new electric lighting plant for maintaining the boulevard street-lighting are being prepared for the City Commission. The present station has been in service about 20 years, and it is proposed to replace it with a new plant. Edward Cahil is president of the commission.

NEWARK, N. J.—Additional capital stock to the amount of $3,000,000, at par, has been sold by the Public Service Electric Company, the proceeds to be used for proposed betterments and extensions to its system and power stations.

TRENTON, N. J.—The Trenton Specialty Engineering Company is planning to install a new boiler plant at its factory.

WASHINGTON, N. J.—Bids will soon be called for by the electric-light committee for furnishing electricity for street-lighting. The five-year contract with the Washington Electric Company expires in February.

CUMBERLAND, MD.—The municipal electric-light plant and water-works station was completely destroyed by fire on Dec. 20, causing a loss of about $60,000. Electrical service has been furnished by the Edison Electric Illuminating Company since July 1, 1916.

PETERSBURG, VA.—An appropriation, it is reported, has been made by the City Council for improvements to the electric-lighting system.

WASHINGTON, D. C.—Bids will be received at the office of the chief signal officer, War Department, Washington, D. C., until Jan. 12, under proposal 896, for furnishing five power switchboards. For further information address Charles S. Wallace, Major, Signal Corps, U. S. Army.

WASHINGTON, D. C.—Bids will be received at the office of the chief signal officer, War Department, Washington, D. C., until Jan. 20, for furnishing 400 telephones and a quantity of telephone supplies. For further information address Alvin C. Vorhis, Captain, Signal Corps, U. S. Army.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing at the various navy yards and naval stations the following supplies: Schedule 565—four blowers, 5000 cu. ft. of air per minute capacity; Schedule 568—furnishing and installing one water tube boiler; Schedule 566—furnishing and installing insulation system; Schedule 578—50 electric heaters; Schedule 575—miscellaneous lighting and power wire, 110,000 ft. telephone wire, 3800 ft. triplex cable; Schedule 578—7000 ft. single-conductor wire, 120,000 ft. ½-in. galvanized steel conduit. Pensacola, Fla., Schedule 562—two transformers. Philadelphia, Pa., Schedule 574—150 steel boiler tubes. Newport, R. I., Schedule 563—1000 lb. copper tubing. Charleston, S. C., Schedule 577—646 brass compression grease cups. Mare Island, Cal., Schedule 582—six oiler sets. Norfolk, Va., Schedule 573—miscellaneous galvanized steel wire rope sockets; Schedule 584—miscellaneous bar copper. Applications for proposals should designate the schedule desired by number.

North Central

DETROIT, MICH.—Bids will be received by the Detroit Library Commission until Feb. 15, to be delivered at the Herbert Bowen Branch Library, West Grand Boulevard and Dix Avenue, for the general construction and mechanical equipment of the new main library building. Plans and specifications may be obtained upon application to Cass Gilbert, 11 East Twenty-fourth Street, New York, N. Y., upon deposit of $200, which will be returned less $28, which will be deducted for cost of reproductions, upon return of plans.

CINCINNATI, OHIO.—The Allis-Chalmers Company is planning to enlarge its Bullock works in Norwood, near Cincinnati, at a cost of about $50,000. Five separate buildings will be erected.

CLEVELAND, OHIO.—Bids will be received at the office of the Commissioner of Purchases and Supplies, City Hall, Cleveland, until Jan. 16, for furnishing cross arms to the department of light and heat. Specifications may be obtained at the office of the division of light and heat, Room 204, City Hall.

CLEVELAND, OHIO.—Bids will be received at the office of the Commissioner of Purchases and Supplies, City Hall, Cleveland, until Jan. 16, for furnishing weather proof copper wire for the division of light and heat. Specifications may be obtained at the office of division of light and heat, Room 204, City Hall.

CLEVELAND, OHIO.—The Allen, Osborne Company, architects and engineers, Rose Building, Cleveland, it is reported, is asking for bids for the construction of an ice rink, hotel and store buildings, market house and power and refrigerating plant, to cost about $600,000 for the Euclid Doan Company, of which A. J. Harvey, the Arcade, is president.

CLEVELAND, OHIO.—The report of the National Board of Fire Underwriters (in connection with an inspection of the electric power at the pumping station in Cleveland, made at the request of the Chamber of Commerce and the Cleveland Credit Men's Association) recommends that an additional source of electric power be secured, in order that the plant may be ready to operate at any time. They also recommend that two additional pumps, with proper electrical equipment, be installed in the plant and that substation equipment be separated from the pump rooms by a solid wall. Energy to operate the pumping station is supplied from the municipal electric plant.

COLUMBUS, OHIO.—The power house and restaurant at Indianola Park was recently destroyed by fire, causing a loss of about $4,500.

IRONTON, OHIO.—The Ironton Electric Company has increased its capital stock from $15,000 to $150,000. Of the proceeds $15,000 will be used to take up outstanding indebtedness, and $120,000 to purchase the local power house and substation of the Ohio Valley Electric Railway Company. The Ohio Valley Electric Railway Company has entered into a contract with the Consolidated Light, Heat & Power Company of Kenova, W. Va., the Boyd County Electric Company of Ashland, Ky., and the Iron Electric Company for energy to operate its traction lines.

MASSILLON, OHIO.—Bids will be received by State Board of Administration, Oak and Ninth Streets, Columbus, until Jan. 29 for construction of cottage for the Massillon State Hospital, near Massillon. Separate bids to be submitted on electric elevator equipment. Harry C. Holbrook, 44 East Broad Street, Columbus, is architect.

MILFORD, OHIO.—Plans, it is reported, have been outlined for a hydroelectric development on the Little Miami River by the officers of the Little Miami River Light & Power Company to supply electricity for lamps and motors in this section. J. W. Hill is consulting engineer; Louis Dolle, Mercantile Library Building, Cincinnati, is interested in the company.

REPUBLIC, OHIO.—At an election held recently the proposal to issue $10,000 in bonds for the installation of an electric-lighting system was carried. Electricity to operate the system will be supplied by the Ohio Light & Power Company of Newark. Part of the proceeds of the bond issue will be used to erect a transmission line to Bloomville, a distance of 4½ miles, where it will connect with the Tiffin-Shelby transmission line of the Ohio Light & Power Company, and the remainder for local distribution system.

BOONEVILLE, KY. — Bonds to the amount of $10,000 have been voted for the installation of an electric light plant. Construction work will begin about Feb. 1.

OWENSBORO, KY.—The installation of an additional 1500-kw. turbo-generator set, to cost about $26,000, has been approved by the City Council. Westinghouse equipment, it is understood, will be purchased.

KEWANNA, IND.—The local electric-light plant has been purchased by Martin Oedekerk of Lebanon.

MADISON, IND.—The Tower Manufacturing Company has secured a much larger building for its plant than the one which was destroyed by fire on Dec. 14. The output of the new plant will be nearly double that of the old plant. The company is in the market for rivet-heading machines, tack machines, transmission and power equipment. For further information address the Cincinnati, Ohio, office. W. F. Robertson of Cincinnati, Ohio, is president.

NOBLESVILLE, IND.—The capital stock of the Noblesville (Ind.) Heat, Light & Power Company has been increased from $100,000 to $250,000.

ALBION, ILL.—The Albion Electric Light & Gas Company is reported to be contemplating the purchase of additional equipment for its plant.

CHICAGO, ILL.—Bids will be received by the Commission on Buildings and Grounds, Board of Education, 730 Tribune Building, Chicago, until Jan. 24 for construction of the Lindbloom High School Building, including general construction work, steam boilers, heat regulation, electric work, ash conveyors, dumb waiters, etc. A. F. Hussander is architect, and John Howatt is chief engineer, 714 Tribune Building.

GIBSON CITY, ILL.—Plans are being considered by the Board of Local Improvements for the installation of an electric lighting plant and for improvements to the water works system, at a cost of about $30,000. Bids, it is understood, will be received about April 1. Melluish & Broyhill, Unity Building, Bloomington, is engneer.

NORMAL, ILL.—The installation of an ornamental lighting system in the business section of the city is under consideration.

SPRINGFIELD, ILL.—A proposition for placing all overhead wires in underground conduits, to be owned by the city and to be leased to the public utility companies, has been submitted to the City Council by A. D. Mackie, general manager of the Springfield Railway & Light Company. The cost of the installation of conduit system is estimated at $390,000.

PLYMOUTH, WIS.—Preliminary surveys are being made by Jeremiah Donohue, civil engineer, Sheboygan, for the construction of a dam across the Mullett River in Plymouth, for the Milwaukee & Fox River Valley Railway Company of Sheboygan. Dr. George Brickbauer, president of the company, which built the electric interurban railways from Plymouth to Elkhart Lake, purchased by the Sheboygan Railway & Electric Company some time ago, retained the franchise for furnishing electricity for lamps and motors in the villages of Elkhart Lake. Glenbeulah and St. Cloud. He is now contemplating extending his transmission line to Mount Cavalry and to build a new power plant. It is estimated that 150 hp. can be developed. At present he is purchasing energy from the Sheboygan Railway & Light Company.

FARIBAULT, MINN.—A petition is being circulated asking for the installation of a municipal electric-light plant in Faribault.

PINE RIVER, MINN.—The Pine River Lighting Company is contemplating extending its transmission lines to Walker.

SPOONER, MINN.—The Minnesota, Dakota & Western Railway Company of International Falls contemplates the erection of an electric transmission line from Spooner to Goodridge, where it will be connected with the Thief River Falls electric lines.

ST. PAUL, MINN.—Plans are being prepared by the St. Paul Gas Light Company for addition to pumping station, to cost about $30,000. Paul Doty is vice-president and general manager.

ST. PAUL, MINN.—The City Council is considering an ordinance requiring the St. Paul Railroad to equip its railroad from Chestnut Street to the west city limits for electrical operation.

BURLINGTON, IOWA.—The Burlington Railway & Light Company has applied to the State Railroad Commission for permission to erect electric transmission lines in Louisa and Des Moines Counties.

GRINNELL, IOWA.—The Iowa Light, Heat & Power Company has applied to the State Railroad Commission for permission to erect an electric transmission line in Carroll County.

MAQUOKETA, IOWA.—Improvements to the local electric system are contemplated by the Iowa Railway & Light Company.

SIOUX CITY, IOWA.—Proposals will be received by William L. Steele, United Bank Building, Sioux City, until Jan. 15 for elevator equipment, including one electric passenger elevator, push button control, and one dumb waiter for St. Vincent's Hospital, Sioux City.

SIOUX CITY, IOWA.—Preliminary plans are being prepared for the construction of a county home for Woodbury County, to include main building and power house, to cost about $75,000 and assembly building, to cost $25,000. William L. Steele, United Bank Building, Sioux City, is architect.

SIOUX CITY, IOWA.—Bids will be received until Feb. 5 for three electric elevators for public use, two for jail use, three for private use, two dumb waiters, two sidewalk lifts and jail equipment of about 100 cells, for the new court house now in course of construction, at a cost of about $100,000. William L. Steele, United Bank Building, Sioux City, is architect.

SPENCER, IOWA.—The contract for improvements to the municipal electric-light and power plant has been awarded to the Northwestern Electric Equipment Company, of St. Paul, Minn., at $38,705. W. Skinner, Plymouth Building, Minneapolis, Minn., is engineer.

TORONTO, IOWA.—The City Council is contemplating the installation of an electric-lighting system, for which an appropriation has been made.

CARROLLTON, MO.—The Water, Light & Transit Company of Carrollton is contemplating extensive improvements to its system if granted an extension of franchise.

FULTON, MO.—The Fulton State Hospital has petitioned the State Legislature for an appropriation for the installation of a new power plant.

GRANDVIEW, MO.—The installation of a municipal electric-light plant in Grandview is under consideration.

JEFFERSON CITY, MO.—Preliminary surveys, it is reported, have been made by the Illinois Traction System of Peoria, Ill., for the construction of an electric interurban railway from Jefferson City to Mexico, via Fulton, a distance of about 45 miles.

KANSAS CITY, MO.—Contract has been awarded by the Hospital Board for construction of addition to the City Hospital, to cost about $90,000, to J. E. Taylor, Ridge Building, Kansas City. Heating and lighting will be supplied from the main plant.

SPRINGFIELD, MO.—At an election to be held Feb. 20 (an extension of date from Dec. 12) the proposal to issue $400,000 in bonds for the construction of a municipal electric-light plant will be submitted to the voters.

WINFRED, S. D.—The contract for the installation of a street-lighting system and the erection of an electric transmission line to Howard has been awarded to the Northern Electric Company of Minneapolis, Minn.

BEATRICE, NEB.—All bids submitted for construction of power house for the municipal electric-light plant and water-works system have been rejected.

LINCOLN, NEB.—The Lincoln Traction Company contemplates the construction of an extension from Lincoln to Omaha, 49 miles long, during 1917.

WEST POINT, NEB.—The property of the West Point Electric Light & Power Company, it is reported, has been purchased by the Continental Gas & Electric Corporation, which controls the Nebraska Gas & Electric Company of Norfolk, Neb.

HIAWATHA, KAN.—The question of closing down the generating station of the municipal electric-light plant and purchasing energy from the Hiawatha Light, Power & Ice Company is under consideration by the City Council.

LENORA, KAN.—Plans are being prepared by George P. Taylor, consulting engineer, Stockton, for the installation of a municipal electric-light plant in Lenora, to cost about $10,000.

McCRACKEN, KAN.—The City Council is considering calling an election to submit the proposal to issue bonds for the installation of an electric-light plant and water-works system to the voters. The cost of the plant is estimated at $30,000. W. B. Rollins & Company, Railway Exchange Building, Kansas City, Mo., are engineers.

MORAN, KAN.—All bids received Dec. 18 for construction of water and light plants have been rejected. New bids will probably be asked for in January. W. B. Rollins & Company, Railway Exchange Building, Kansas City, Mo., are engineers.

QUINTER, KAN.—An election will soon be called to submit to the voters the proposal to issue $10,000 in bonds for the installation of a municipal electric-light plant. George P. Taylor of Stockton is engineer.

SALINA, KAN.—The Salina Light & Power Company, it is reported, contemplates the installation of an additional 2500-kw. generating unit at its plant.

WICHITA, KAN.—The Arkansas Valley Interurban Railway Company has applied to the Public Utilities Commission for authority to issue $2,000,000 additional in bonds and $900,000 additional in capital stock, for the purpose of making extensions into other countries, including Sumner, Butler, Cowley, McPherson, Marion, Rice, Saline and Dickinson.

Southern States

ALBEMARLE, N. C.—W. L. Cotton of Albemarle, representing capitalists, it is reported, is securing land and riparian rights with a view of constructing a power dam across Yadkin River for a hydroelectric power development.

SUMMERVILLE, GA.—Steps have been taken by local business men to organize a company to install and operate an electric-light plant in Summerville. The cost is estimated at about $5,000. C. C. Cleghorn, S. C. Martin and others are interested.

PLANT CITY, FLA.—The Plant City Public Service Company has been granted permission to extend its electric transmission lines out on the Thonotosassa Road, the Hopewell Road, the Midway Road and the Tampa-Plant City Road.

FRANKLIN, TENN.—Plans are being prepared by Thomas J. Davis of Franklin for construction of administration building, to include main dining hall, kitchen, bakery, refrigerating apparatus, domestic science

rooms, office, heating plant for this and six adjoining buildings; engine room equipped for generating electricity for lamps and motors for all the buildings. The cost of building, including equipment, is estimated at $30,000.

THOMAS, ALA.—The Republic Iron & Steel Company contemplates the construction of an electric plant to supply energy at Palos, Warner and Sayreton. C. T. Fairburn of Birmingham is manager of the Southern district.

JONESBORO, ARK.—Bids will be received by A. E. Lockhart, secretary of school board, until Jan. 16, for construction of a high school building, including heating, lighting and plumbing, etc. Plans may be obtained from the secretary upon deposit of $10.

NEW ORLEANS, LA.—Plans are being considered for extensive improvements for Canal Street, which will include an ornamental lighting system. Probably nothing will be done until early in 1918.

NEW ORLEANS, LA.—Extensive improvements and extensions are contemplated by the Trans-Mississippi Terminal Company of New Orleans to its terminal facilities, especially for mechanical loading and unloading devices. The cost of the work is estimated at about $350,000.

SHREVEPORT, LA.—The Southwestern Gas & Electric Company, it is reported, contemplates extensions to its power house, involving an expenditure of about $100,000. A. G. Curtis is manager.

CRESCENT, OKLA.—The installation of an electric-light plant in Crescent is under consideration.

DUKE, OKLA.—The installation of a municipal electric-light plant in Duke is under consideration.

LAVERNE, OKLA.—The Laverne Electric Light, Power & Ice Company, recently incorporated, contemplates the construction of an electric plant to develop 75 hp., at a cost of about $30,000. W. H. Lewis & Son are managers.

NORMAL, OKLA.—Plans are being considered for the installation of a municipal electric-light plant in Normal.

WEWOKA, OKLA.—An election has been called to submit the proposal to issue $8,000 in bonds for improvements and extensions to the municipal electric-light plant.

BALLINGER, TEX.—The Ballinger Electric Light & Power Company has filed amendments to its charter changing its name to the Ballinger Light, Power & Ice Company and changing its purpose.

COLLEGE STATION, TEX.—All bids for construction of laboratory building and power house and domestic arts building at Prairie View, at College Station for the Agricultural and Mechanical College, have been rejected and new bids will be received until Jan. 8. The cost of the laboratory building is estimated at $96,000; the power house, $55,000, and the domestic arts building, $50,000. All lighting and heating will be supplied from a central plant.

DALLAS, TEX.—Negotiations are under way for the consolidation of the Texas Traction Company, which operates an interurban railway between Dallas and Dennison, and the Southern Traction Company, which operates an interurban car line between Dallas and Waco and Dallas and Corsicana. It is proposed to extend the Waco railway south to San Antonio, via Austin, a distance of about 185 miles, soon after the merger goes into effect.

FORT WORTH, TEX.—Plans have been prepared by Sanguinet & Staats of Fort Worth for the construction of a high school building on the old Fort University site, 300 ft. by 236 ft.; to be equipped with electric lamps, vacuum cleaning system, automatic clock and bell system and intercommunicating telephone system.

KEMP, TEX.—The installation of an electric-lighting system in Kemp is under consideration.

SAN ANGELO, TEX.—Bids will be received by C. C. McBurnett for the erection of a seven-story hotel with 110 rooms and about 75 baths; also to include refrigerating plant, elevators, vacuum cleaning system, etc., to cost about $150,000.

SAN ANGELO, TEX.—The San Angelo Water, Light & Power Company has filed an application with the State Board of Water Engineers for permission to build a reservoir for the purpose of impounding 380,000 acre ft. of the flood waters and natural flow of the Concho River to supplement the water supply of San Angelo.

UVALDE, TEX.—Negotiations are under way between the Uvalde Electric Light & Power Company and W. H. Wiss of Kansas City, Mo., and associates for the purchase of the local plant. The new owners, it is said, contemplate extensive improvements to the system.

Pacific States

EDMONDS, WASH.—The Edmonds Electric Light & Power Company has closed a contract (for a term of years) with the Shell Oil Company of California to supply electricity for lamps and motors at its large distributing plant at Richmond Beach. Work will begin at once on the erection of a 2300-volt transmission line to Richmond Beach. A. A. Cobb is superintendent.

KEYPORT, WASH.—Bids will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until Jan. 15 (extension of date from Dec. 18) for a telephone cable connection between the Pacific coast torpedo station, Keyport, Wash., and the Puget Sound navy yard, Wash.; also an electric power transmission line from the Olympic Power Company's pole line to the radio building at the above-named torpedo station.

CHICO, CAL.—A proposal for the installation of a municipal electric plant, to cost about $750,000, has been submitted to the Business Men's Association by Denny Murphy. The plans provide for utilizing water rights on Deer Creek, owned by Mr. Murphy.

WILLOWS, CAL.—Preparations are being made by the Sacramento Valley Colony Company of Willows for the installation of 70 electrical pumping plants for irrigation purposes.

WILLOWS, CAL. — The Glenn-Cadora, Prince Districts, have recently voted to issue bonds for the construction of two pumping stations for pumping water for irrigating about 18,000 acres; one to be located at Sidds Landing and the other north of Princeton, to cost about $144,000.

CALDWELL, IDAHO. — The Caldwell Traction Company contemplates equipping its railway between Caldwell, Greenleaf and Wilder, 10 miles in length, for electrical operation. The road is leased from the Oregon Short Line and now operated by steam.

SALT LAKE CITY, UTAH.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until Jan. 25 for the installation, complete, of a hoistway, hydraulic freight lift, etc., in the United States post office and court house at Salt Lake City. For details see proposal columns.

FLAGSTAFF, ARIZ.—Plans are being considered by the Arizona Lead & Zinc Company for the construction of a large hydroelectric plant at Mooney Falls on Cataract Creek. Energy developed at the plant will be transmitted to the mines of the company to operate machinery and other equipment. The company also proposes to erect a large mill for the reduction of ore by the electrolytic process.

GLOBE, ARIZ.—Application has been made to the City Council by C. H. Munson for a franchise to enter the city of Globe with an interurban railway which he proposes to build between Globe and Miami.

JEROME, ARIZ. —The Arizona Power Company, it is reported, has awarded contract for the construction of an additional electric generating station, to cost about $1,000,000. The proposed plant will be operated by steam power and will have an output of about 10,000 hp. This energy will supplement that which the company now obtains from its hydroelectric plants at Fossil Creek on the lower Verde River. The transmission systems of the two plants, it is stated, will be connected, and that when additional power from the new station is available, a transmission line will be erected to Jerome to provide energy to operate the machinery of the mine and ore mills here.

NOGALES, ARIZ.—The International Gas Company, it is reported, contemplates extending its transmission lines to Cananea and other mines and towns in northern Sonora, Mex.

WILCOX, ARIZ—The Council has granted Neil McMillan a franchise to construct and operate an electric-light plant in Wilcox.

YUMA, ARIZ.—Contracts have been signed by which the Southern Sierras Power Company of Riverside, Cal., will supply electricity for lamps and motors and domestic purposes in the city of Yuma from El Centro, Cal. The plans provide for the erection of a high-tension transmission line from El Centro, Cal., to Yuma, a distance of about 70 miles, at a cost of about $200,000. The proposed line will also supply energy to enable the ranchers in Imperial Valley to irrigate about 500,000 acres of land, and it will also supply power to operate two dredges at Hanlon's Heading, the main intake of the Colorado River of the Imperial canal system.

DILLON, MONT.—Bids, it is reported, will be received by Jesse M. Warren, Daily Bank Building, Butte, until Jan. 15, for construction of hotel, three stories and basement, 75 ft. by 115 ft., including heating, electric lighting, plumbing, etc., to cost about $75,000, in Dillon.

AUSTIN, NEV.—An electric-light franchise has been granted to Messrs. Berg & Rice of Austin to install an electric-light plant here. The equipment of the plant will include a 25-kw. generator driven by a crude oil engine.

FALLON, NEV.—The Fallon Electric Railroad Company is contemplating the construction of an electric railway from Fallon to Stillwater, a distance of 41 miles, during 1917.

Canada

DRUMHELLER, ALTA. — The Northwestern Engineering & Supply Company of Calgary has been granted a franchise to operate an electric-light and power plant in Drumheller. With the agreement for street-lighting the company also takes over the pumping service for the waterworks system.

BATHURST, N. B.—The Bathurst Lumber Company contemplates a 10,000 hp. power development at Grand Falls on the Nepisigut River, about 18 miles from Bathurst, in connection with the construction of a paper mill.

AYLMAR, ONT.—The installation of two gas engines at the municipal electric light and water-works plant is under consideration.

HEPWORTH, ONT. — The ratepayers have approved a by-law authorizing the Hepworth Heat, Light & Power Company to install a distributing system to supply electricity in Hepworth.

MICHIPICOTEN HARBOR, ONT.—The Michipicoten Power & Paper Company, recently incorporated with a capital stock of $6,500,000, contemplates the construction of a 150-ton news mill at Michipicoten Harbor, about 120 miles west of Sault Ste Marie, and also a 125-ton ground wood pulp mill. The cost of the mills and the water power development is estimated at about $6,000,000. Lewis Miller Wood, of Toronto, president of the Standard Chemical Iron and Lumber Company, is at the head of the new company. The headquarters of the Michipicoten company are in Toronto.

TORONTO, ONT.—Tenders will soon be called by the Provincial Hydro-Electric Power Commission for a 13,000/2200-volt distribution system to supply electricity to Mimico, New Toronto, the Mimico Hospital for the Insane, numerous brick yards and other industries. The initial installation will provide for an output of about 4000 hp. F. A. Gaby is chief engineer.

QUEBEC, QUE.—The Dominion Iron & Wrecking Company of Quebec has taken over the plants of the Standard Steel Foundries at Outremont and the Consolidated Brass Foundries at Point aux Trembles, Que. The plants, it is understood, will be consolidated for the purpose of manufacturing munitions. New equipment, including 15 electric furnaces, will be installed at the Consolidated Foundries' plant.

ARCOLA, SASK.—The purchase of the local electric-light plant to be owned and operated by the municipality is under consideration.

Miscellaneous

PANAMA—Bids will be received at the office of the purchasing officer of the Panama Canal, Washington, D. C., until Jan. 12, under circular No. 2097, for furnishing cable and switch ties. For further information address Major Earl I. Brown, general purchasing officer.

PANAMA.—Bids will be received at the office of the general purchasing officer, the Panama Canal Commission, Washington, D. C., until Jan. 11 for furnishing galvanized steel, sheet brass, copper tubing, cable thimbles, drills, bits, pipe cutters, steel clamps, clocks, detonators, etc. Blanks and general information relating to the circular (No. 1109) may be obtained at the above office or at the offices of the assistant general purchasing agents, 24 State Street, New York, N. Y.; 614 Whitney-Central Building, New Orleans, La., and Fort Mason, San Francisco, Cal.

PANAMA.—Bids will be received at the office of the general purchasing officer, the Panama Canal, Washington, D. C., until Jan. 16 for electric cable, wire, transformers, panel boards, ammeters, voltmeters, electric fixtures, electrical attachments, fire alarm boxes, gasoline torches, drill points, lamp carbons, pliers, insulating paper, pothead compound, etc. Blanks and general information relating to this circular (No. 1111) may be obtained at the above office or the offices of the assistant purchasing agents, 24 State Street, New York, N. Y.; Whitney-Central Building, New Orleans, La., and Fort Mason, San Francisco, Cal.

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14,236. LINE-SWITCH; John Newberry Reynolds, Greenwich, Conn. App. filed March 16, 1915. Telephone switch.

1,209,655. LAMP-SOCKET; William F. Anklam, Detroit, Mich. App. filed Aug. 31, 1914. For use in connection with vehicle lamps.

1,209,680. METHOD OF AND APPARATUS FOR DETECTING THE PRESENCE AND LOCATION OF SUBMERGED METALLIC BODIES; Patrick B. Delany, South Orange, N. J. App. filed April 30, 1915. Such as submarines, floating mines.

11,209,689. TELEPHONE SYSTEM; Francis W. Dunbar, Chicago, Ill. App. filed May 28, 1909. Apparatus by which the busy and idle conditions of a telephone line are established.

1,209,704. METHOD OF AND APPARATUS FOR ELECTRIC WELDING; Charlie L. Hawes, Ashtabula, Ohio. App. filed April 6, 114. Maufacture of metallic tubes of comparatively short length and more particularly still to tapered ferrules such as are employed on the handles of rakes, hoes and like implements.

1,209,710. WIRE EELCTRODE FOR ELECTROLYTIC PURPOSES; Max Huth, Charlottenburg, Germany. App. filed July 7, 1916. Wire electrodes are arranged so that the individual electrode wires, which are connected to a common conductor of the current supply, hang freely from this conductor and are weighted at their lower ends in order to put the individual wires under mechanical tension.

1,209,735. REGISTERING RECORDING AND COMPUTING SYSTEM; George W. Lorimer, Piqua, Ohio. App. filed July 12, 1912. Concerning sales or other business transactions.

1,209,744. ELECTRIC SWITCH; Harry J. Morey and Fay A. Brogden, Syracuse, N. Y. App. filed Nov. 29, 1912. Pendant push-button switches.

1,209,766. APPARATUS FOR MEASURING THE MAXIMUM VALUES OF ALTERNATING-CURRENT VOLTAGES; Clayton H. Sharp, White Plains, N. Y. App. filed Oct. 26, 1914. A suitable electric valve or rectifier is used to charge a condenser to the peak value of an alternating wave.

1,209,775. DYNAMO-ELECTRIC MACHINE; Charles W. Starker, Pittsburgh, Pa. App. filed April 1, 1915. Improvement.

1,209,776. DYNAMO-ELECTRIC MACHINE; Charles W. Starker, Pittsburgh, Pa. App. filed April 1, 1915. Motor frame of the split type.

1,209,792. SWITCH; Herbert W. Young, Chicago, Ill. App. filed Dec. 11, 1913. Adapted for outdoor use by reason of which the switch may be readily opened when desired regardless of the snow and ice which may be gathered thereon.

1,209,793. SIGNAL-LANTERN; Alfred A. Ziegler, Boston, Mass. App. filed Nov. 6, 1915. Improvement.

1,209,825. TELEPHONE SYSTEM; John Erickson, Chicago, Ill. App. filed Dec. 18, 1908. Improvement.

1,209,826. TELEPHONE SYSTEM; John Erickson, Chicago, Ill. App. filed Dec. 18, 1908. Substations are provided with rotary calling dials, and especially to systems in which the said dials are used for controlling the operations of switches that have one motion to select groups and another motion to connect with a line in any selected group.

1,209,834. TELEPHONE-EXCHANGE SYSTEM; Charles L. Goodrum, New York, N. Y. App. filed May 10, 1915. Automatic ringing systems for party lines connected with an automatic telephone exchange.

1,209,835. PROCESS OF TREATING MATERIALS ELECTROLYTICALLY; William E. Greenawalt, Denver, Col. App. filed May 13, 1913. Improvements.

1,209,842. WIRE-CONNECTOR; Ormond E. Hunt, Detroit, Mich. App. filed Feb. 24, 1914. Water proof.

1,209,852. ILLUMINATING DEVICE FOR TALKING-MACHINE RECORDS; Chester A. Kotterman, Washington, D. C. App. filed June 12, 1916. Improvements.

1,209,862. ELECTRIC HEATING APPLIANCE; Tiodolf Lidberg, Chicago, Ill. App. filed Jan. 19, 1916. Adapted for heating a liquid bath.

1,209,871. METHOD OF AND APPARATUS FOR ELECTRIC WELDING; Frank H. Neff, Cleveland, Ohio. App. filed June 15, 1915. Comprises a plurality of contacting surfaces or arcing points to which the high-voltage pressure is successively momentarily applied.

1,209,892. ELECTRICAL CONNECTOR; August J. Seemann, Milwaukee, Wis. App. filed Nov. 22, 1915. For connecting the railway cars of a train.

1,209,908. LAMP-SOCKET; Clarence A. Vetter, Pittsburgh, Pa. App. filed Dec. 26, 1913. Improvements.

Record of Electrical Patents

Notes on United States Patents issued on Dec. 26, 1916.

1,209,909. LAMP-SOCKET; Clarence A. Vetter, Pittsburgh, Pa. App. filed Dec. 26, 1913. Incandescent lamps.

1,209,910. LAMP-SOCKET; Clarence A. Vetter, Pittsburgh, Pa. App. filed Jan. 16, 1915. Enables the cap and shell to be connected in any position relative to each other.

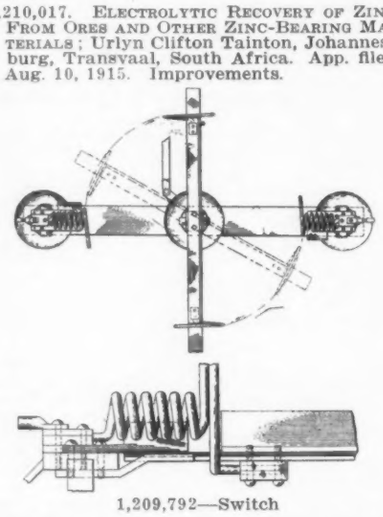
1,209,932. HAND-GENERATOR; Charles P. Bradley, Pemberton, N. J. App. filed Nov. 24, 1914. Lamp may be operated.

1,209,944. PNEUMATIC PUMP; Charles A. De Rigne, Los Angeles, Cal. App. filed Feb. 28, 1916. Designed for inflating the tires of automobiles, bicycles and the like.

1,209,961. ELECTRICALLY-OPERATED TYPEWRITER; Ernest Hausberg, Charles City, Iowa. App. filed July 25, 1912. Mechanically operated parts of the machine are reduced to a minimum.

1,209,992. DYNAMO-ELECTRIC MACHINE; Henry V. Nye, West Allis, Wis. App. filed Nov. 9, 1910. For colling such devices.

1,210,017. ELECTROLYTIC RECOVERY OF ZINC FROM ORES AND OTHER ZINC-BEARING MATERIALS; Urlyn Clifton Tainton, Johannesburg, Transvaal, South Africa. App. filed Aug. 10, 1915. Improvements.



1,209,792—Switch

1,210,018. CURLING-IRON; Samuel Trood, Edgewood Park, Pa. App. filed Feb. 4, 1913. Embodying a resiliently supported heater element for preventing breakage, and a swiveling attachment whereby the iron may be rotated with respect to the supply conductors.

1,210,024. AUTO TAIL-LAMP SIGNAL; ; George F. Wakefield, San José, Cal. App. filed Dec. 27, 1915. Rear end of automobiles.

1,210,027. SIGNAL-LAMP; Lee H. Wilbur and Walter F. Wilbur, Dunkirk, N. Y. App. filed March 5, 1915. In case the bulb is extinguished by burning out, a second bulb will automatically swing into place.

1,210,029. BRUSH FOR DYNAMO-ELECTRIC MACHINES AND METHOD OF ATTACHING CONDUCTORS THERETO; Carl B. Auel, Wilkinsburg, Pa. App. filed Sept. 28, 1912. Improvement.

1,210,036. TERMINAL BLOCK FOR ELECTRICAL MEASURING INSTRUMENTS; William M. Bradshaw, Wilkinsburg, Pa. App. filed Feb. 19, 1914. For watt-hour meters.

1,210,049. ELECTRICAL PROTECTIVE DEVICE; Almon W. Copley, Wilkinsburg, Pa. App. filed Dec. 14, 1915. Actuated only when the temperature of the translating device to be protected reaches a predetermined value.

1,210,058. ELECTRICAL PROTECTIVE DEVICE; Charles Le G. Fortescue, Pittsburgh, Pa. App. filed Sept. 21, 1915. Protecting electrical translating device in accordance with the temperatures thereof.

1,210,062. ELECTRICALLY-HEATED CULINARY APPARATUS; William S. Hadaway, Jr., East Orange, N. J. App. filed June 25, 1910. Utilized with any of the usual forms of chafing dishes and similar devices without necessitating any structural change therein.

1,210,068. CABLE-TERMINAL PLUG RETAINER; Ellsworth A. Hawthorne, Bridgeport, Conn. App. filed June 22, 1914. For lamps and other apparatus having socket members, or the like.

1,210,078. ADJUSTABLE SUPPORT FOR ELECTRIC LAMPS; Knut F. M. Lindblad, Everett, Mass. App. filed Feb. 26, 1916. Adjustable pendant.

1,210,086. ELECTRIC WATER-HEATER; James C. Leitch, Los Angeles, Cal. App. filed July 6, 1915. Portable.

1,210,094. SYSTEM OF DISTRIBUTION; Charles McL. Moss, Pittsburgh, and Henry A. Travers, Wilkinsburg, Pa. App. filed Dec. 4, 1915. Automatically-controlled means for absorbing the excess-regenerated energy produced by devices operating in such systems.

1,210,110. UNIVERSAL CABLE-TIP; Frank W. Smith, Kansas City, Mo. App. filed March 29, 1915. For electrically connecting cables to spark plugs of explosive engines on automobiles.

1,210,112. ELECTRIC PROD-POLE; William A. Smith, San Angelo, Tex. App. filed Aug. 9, 1915. Poles to be used in the place of the ordinary prod pole for driving or controlling animals on ranches, stockyards, and similar places.

1,210,176. DUPLEX RECEPTACLE; George P. Knapp, Bridgeport, Conn. App. filed June 19, 1915. Adapted to receive a plurality of (in the present instance two) connecting caps.

1,210,204. WEIGHING-SCALE; Orwell C. Reeves, Toledo, Ohio. App. filed March 4, 1915. Articles may be separately weighed without necessitating the removal of any of them from the scale platform.

1,210,214. SPARKING INDICATOR; Herbert J. Sass and Oliver H. Shaw, Chicago, Ill. App. filed Feb. 29, 1916. Plugs of an engine may be readily and quickly tested to determine whether or not the same are operating.

1,210,225. FLASH-LIGHT DEVICE; Paul C. Smalley, Newark, N. J. App. filed Feb. 13, 1915. Lens with reflector-positioning means formed on its inner face, which may consist of an annular recess.

1,210,245. ELECTRIC-BELL ATTACHMENT; Thomas C. Williams, Washington, D. C. App. filed June 2, 1916. Used on street cars.

1,210,262. LAMP-LOCK SOCKET; Reuben B. Benjamin and James Imboden, Chicago, Ill. App. filed April 3, 1914. Lock the lamp in the socket in such a manner that the same will not jar loose due to vibration.

1,210,283. SIGNALING APPARATUS; Carl G. Ender and Guy A. Barber, Wilkinsburg, Pa. App. filed Feb. 18, 1916. For vehicles.

1,210,290. INCANDESCENT-LAMP SOCKET; George Herbert Feick, Baltimore, Md. App. filed Nov. 29, 1915. For allowing the proper amount of flexibility between the cord and the protector.

1,210,314. TELEPHONE TOLL SYSTEM; Alfred U. Hoefer, East Orange, N. J., and Henry M. Bascom, New York, N. Y. App. filed Oct. 30, 1914. Improvements.

1,210,316. DEPILATORY APPARATUS; William B. Hollingshead, Mount Vernon, N. Y. App. filed Nov. 23, 1912. Electric current may be conveniently controlled and guided.

1,210,331. THERMAL CIRCUIT-CONTROLLER; Frank Kuhn, Detroit, Mich. App. filed March 8, 1913. Automatic cutouts for electric circuits.

1,210,335. LIGHTING SYSTEM FOR MOTOR-VEHICLES; Charles T. Lemon, Ripley, Ohio. App. filed Jan. 12, 1916. Circuit-closing device.

1,210,336. TRAFFIC-SIGNAL; James A. McIntosh, Portland, Ore. App. filed Feb. 16, 1916. For use upon automobiles and other motor vehicles.

1,210,356. CIRCUIT-CLOSING DEVICE; Edward Paul, New Bremen, Ohio. App. filed April 3, 1916. For use in electric street-lighting systems wherein a plurality of arc lamps are connected in series.

1,210,365. LAMP ATTACHMENT FOR CELLS; Michael C. Regan of the United States Army. App. filed Jan. 7, 1916. Whereby miniature or other electric lamps may be attached to dry or other cells and supportd thereon to swing into and out of engagement with one terminal or connector for lighting or disconnecting the lamp.

1,210,386. AUTOMATIC TELEPHONE SYSTEM; William Kaisling, Chicago, Ill. App. filed June 5, 1911. For use in connecting a calling line with an idle trunk circuit or first selector switch upon initiation of a call.